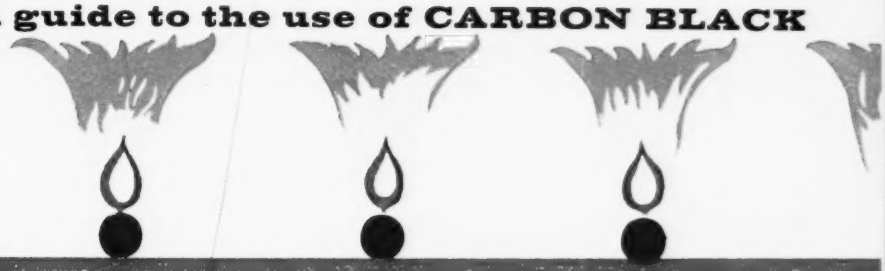
RUBBER WORLD

A guide to the use of CARBON BLACK



DECEMBER, 1960

Shell Isoprene Rubber on a commercial mill. Note the white color. It accounts for exceptional brilliancy in finished items.

BULLETIN:

Shell Chemical announces increased production of polyisoprene—and tells how you can get immediate shipments of this revolutionary new rubber

Shell Chemical answers 16 questions about a new synthetic called Shell Isoprene Rubber. It is the first commercial polymer ever made that unites the advantages of natural and synthetic rubber.

Here is what manufacturers of truck and automotive tires, surgical tubing, toys, bathing caps, shoes, rubber bands and hundreds of other rubber products should know about new Shell Isoprene Rubber.

1. How new is Shell Isoprene Rubber? It is very new. For over 40 years chemists have struggled to reproduce the cis-polyisoprene structure of natural rubber. And produce a synthetic that could compete in price with natural rubber.

Laboratory success was first reported in 1955. Commercial success was reported by Shell in 1959. Since then, over 3,000,000 pounds of this remarkable new rubber have been sold to a wide variety of users.

2. Is Shell Isoprene Rubber the same as natural rubber? For all intents and purposes it is. Shell Isoprene Rubber is the first commercially made synthetic rubber to provide *high resilience* and *low heat build-up*. Its basic molecular structure is cis-polyisoprene—the same as natural rubber.

New Shell Isoprene Rubber can be used for applications that now require natural rubber. This includes such uses as heavy-duty truck tire treads, carcasses and sidewalls.

3. Does it have the advantages of synthetic rubber? Yes. Because Shell Isoprene Rubber is made by a chemically controlled process, it has the uniformity of synthetic rubber. New Shell Isoprene Rubber is readily available. And comes in easy-to-handle, 65-pound bales.

4. What color is Shell Isoprene Rubber? White. This unique whiteness accounts for the brilliancy that results when colors are added. Your customers will get better and brighter-looking products.

5. Can you be sure of uniformity? You certainly can. At Shell's Control Laboratories, specially trained professional technicians devote full time to the quality control of Shell Isoprene Rubber.

Samples are taken from tanks, lines and bales and subjected to rigid tests. The Shell Isoprene Rubber is com-

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pounded, processed and cured to assure correct processing performance.

6. Does Shell Isoprene Rubber require different compounding ingredients than natural rubber? No. Shell Isoprene Rubber can be used with the same plasticizers, reinforcing agents, softeners, accelerators, vulcanizing ingredients and coloring agents as natural rubber.

Slight modifications of some formulations may be required to obtain optimum properties.

7. Can Shell Isoprene Rubber be processed in conventional equipment? Yes. Its processing characteristics, compounding formulations and vulcanization techniques are all similar to those of natural rubber.

Shell Isoprene Rubber is also compatible with natural rubber and most synthetic polymers and can be blended with them in any proportion.

New Shell Isoprene Rubber requires less mastication than natural rubber and it can be chemically plasticized at a faster rate. If it is subjected to the same breakdown as natural rubber, Shell Isoprene Rubber will become too soft for practical use.

Caution should be exercised when chemical plasticizers are used. They have a more rapid action with new Shell Isoprene Rubber than with other elastomers.

8. How does Shell Isoprene Rubber handle on the mill? It can be handled on the mill without pre-breakdown. When a smooth rolling bank is attained, compounding ingredients can be added in the normal way.

9. How about mold flow? New Shell Isoprene Rubber is superior to natural rubber in mold flow. This allows for better and more complete fill in intricate molds, finer detailing and increased production as a result of fewer rejects.

10. What can you make with Shell Isoprene Rubber? Since its initial introduction for commercial evaluation, manufacturers have discovered that Shell Isoprene Rubber's high resiliency, low heat build-up, color, uniformity, purity, mold flow and ease of processing make it ideal for hundreds of applications. Here are just a few:

Heavy-duty truck tire treads, carcasses and sidewalls, automobile bushings, motor mounts, protective bumpers, windshield wipers, surgical tubing, intravenous feeding tube connectors, crutch tips, toys, rubber thread, swim fins, bathing caps, instrument bellows, telephone ear pieces, electrical connectors, wire and cable insulation, shoe heels and soles and rubber bands.

Its future applications are unlimited.

How to get Shell Isoprene Rubber

To order, call your nearest Shell Chemical sales office. They are located in New York, Cleveland, Ohio and Lakewood, California.

Shell Isoprene Rubber and many of the more popular SBR types are stocked at the eight Shell warehouses in the cities shown above.

11. Can you get technical assistance from Shell? Yes. In addition to Research and Control Laboratories, Shell Chemical maintains a complete Technical Service Laboratory at Torrance, California. Both laboratory and in-plant assistance are available.

12. How much Shell Isoprene Rubber will be made? Shell's newly enlarged facilities at Torrance can produce 40,000,000 pounds of Shell Isoprene Rubber a year.

A second Shell Chemical plant with an annual capacity of 80,000,000 pounds is now under construction at Marietta, Ohio. This new plant is expected to be on stream late in 1961.

13. How about availability? New Shell Isoprene Rubber is now available in carload lots from Torrance. Shell Chemical can fill your order immediately.

For less than carload lots, Shell Isoprene Rubber is available from eight Shell Chemical warehouses. Their locations are: Boston, Trenton, Baltimore, Lima, Nashville, Chicago, Portland, Oregon and Los Angeles.

14. Will Shell sell mixed loads of Shell Isoprene Rubber and SBR at carload prices? Yes. Mixed loads of Shell Isoprene Rubber and any of the SBR types on Shell's price list will be shipped from Torrance at applicable carload prices.

Shell Chemical also stocks many of the more popular SBR polymers at Eastern warehouses. These may be purchased to round out loads meeting minimum tariff weights required for truckload or carload prices.

15. Will Shell Isoprene Rubber completely replace natural rubber? Only in the event of a national emergency.

A U. S. Cabinet Member recently stated: "Commercial development of polyisoprene is an important aid to national defense. Its availability in sufficient quantities will free the United States completely from dependence on foreign sources of rubber in time of emergency."

16. Are samples and technical information available? Yes. Simply write or call your nearest Shell Chemical, Synthetic Rubber Division sales office.

They are: 110 West 51st Street, New York 20, N. Y., JU 6-5060; 1296 Union Commerce Building, Cleveland 14, Ohio, TO 1-8096 and 5230 Clark Street, Lakewood, California, SP 3-4997.

Samples of new Shell Isoprene Rubber and technical information are yours for the asking.

A bulletin from

Shell Chemical Company

SHELL

Synthetic Rubber Division

RUBBER WORLD

VOLUME 143 NUMBER 3 DECEMBER, 1960

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Cover design by George Booth

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BPA NBP BPA

news of the rubber world

December, 1960

This month RUBBER WORLD continues the on-the-spot reports of European conferences by R. G. Seaman. A report on the Second International Synthetic Rubber Symposium sponsored by "Rubber & Plastics Age" held in London, October 11-13, starts on page 95. In addition, more of the DKG Berlin meeting abstracts appear (page 108). Abstracts of papers at both of these overseas meetings will be carried in future issues until all have been presented.

Prices in the rubber industry seem slated to squeeze profit margins if the present trend continues. Natural rubber price decline has led to reductions in Shell Isoprene Rubber (IR) and some SBR latices (page 140). Several of the large tire producers have announced reductions on passenger tires also. While the lower raw rubber prices may be a boon to rubber product manufacturers, the pressure for lower product prices will maintain current low profits on many rubber items.

B. F. Goodrich Co. researchers find that compression set is a sensitive measurement of the effects of radiation and present (page 75) a method for obtaining such information. The results of their work indicate a need of more radiation-resistant elastomers and more effective antirads.

Carbon black, workhorse of the rubber industry, can often be misused or ill-used for the problem at hand, owing to the many grades available. RW is pleased to present (page 90) a guide to the use of carbon black for the education of the younger compounders and, perhaps, to jog the memory of some older compounders. A recognized expert, Dr. I. Drogin, has compiled this information into a convenient single reference.

Akron University has added Henry Nicholas Ridley to the Rubber Science Hall of Fame (page 105). Ridley introduced the first rubber seeds to Malaya and developed herringbone tapping.

Rubber has replaced plastic in one glamourous application, reversing a trend in some other areas. Bell Telephone Laboratories has found an elastomer base for carrying the magnetic particles in recording sleeves preferable (page 83).

News about

B.F.Goodrich Chemical *raw materials*

for:

better flow

better extrusion

better calendering

USE

HYCAR 1312

A LIQUID NITRILE POLYMER

As a plasticizer both in nitrile rubber and vinyl plastisols, Hycar 1312 is non-extractable, non-migrating and non-volatile. It provides nitrile rubber compounds with excellent building and knitting characteristics—has good tack. Examples of applications where it is being used include tank linings, building of rolls and fabrication of hose.

A carboxy modified variation, Hycar 1300x2 possesses properties similar to those of 1312, but with the added advantage of cross-linking through the carboxyl group by metallic oxides, epoxy resins, and other similar agents.

For more information about either of these Hycar polymers, or other Hycar rubbers and latices, write Dept. FB-11, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Hycar

Rubber and Latex

B.F.Goodrich Chemical Company
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See our catalog in Sweet's Product Design File

B.F.Goodrich GEON vinyls • HYCAR rubber and latex • GOOD-RITE chemicals and plasticizers

ST. JOE
Fast Curing Type
ZINC OXIDES

Specially Developed to Meet Your Activation Requirements

GRADE	Black Label 20	Red Label 30	Green Label 42	Green Label 43
Av. Particle Size D_1-Microns	.20	.23	.28	.30
N_2 Specific Surface-Sq. M/gram	10.91	7.04	5.27	5.02
Total S as SO_3	.05	.05	.05	.05
Apparent Density—Lbs./cu. ft.	25	28	30	32
Incorporation	Good	Good	Fast	Easy
Reinforcing Properties	Maximum	Excellent	Excellent	Good
Application	Very fine particle size, giving maximum reinforcement and activation. For highest quality rubber goods.	Excellent reinforcing and activating properties. Having fewer extremely fine particles, it is easier to incorporate than Black Label No. 20	General purpose type. Excellent activating and moderate reinforcing properties. Faster rate of incorporation than Black Label No. 20 or Red Label No. 30	Large particle size type for easy incorporation. Good activating and reinforcing properties.

For activation purposes, 2 to 5 parts of St. Joe zinc oxide normally are used per 100 parts of rubber. The finer particle size St. Joe Zinc Oxides are more effective as activators than the coarser grades, due to their greater active surface and more positive (+) electrical charge which gives faster chemical reaction rates as well as greater solubility in the rubber. For further information, write for St. Joe's Technical Data Book.

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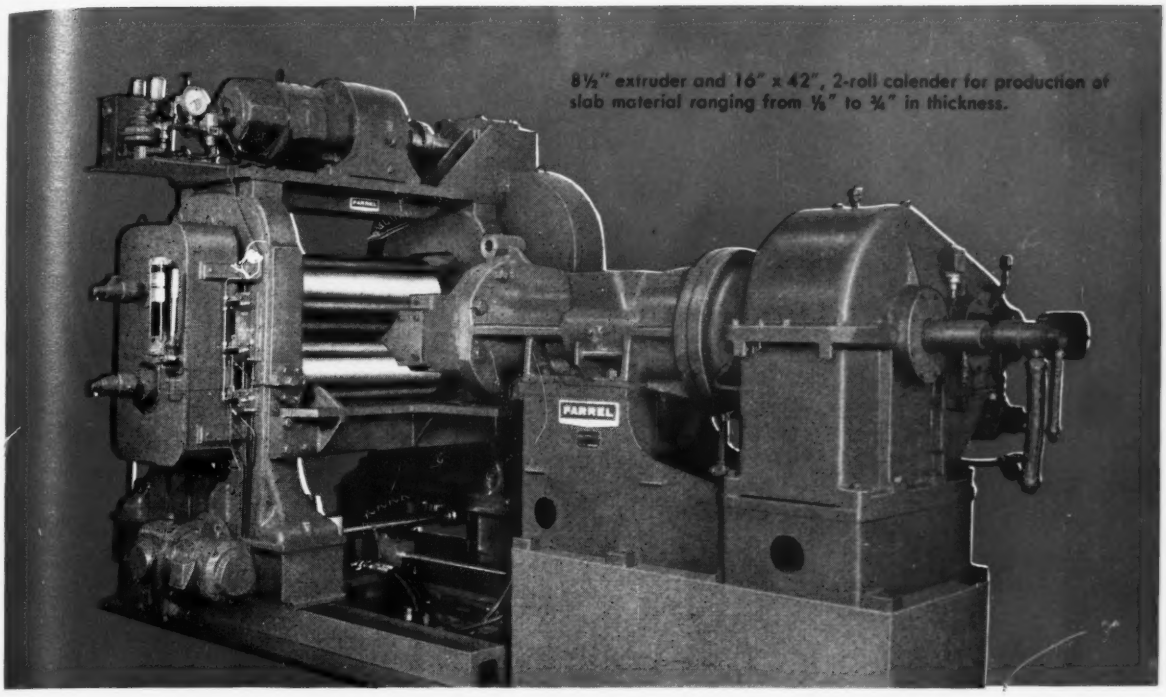

8½" extruder and 16" x 42", 2-roll calender for production of slab material ranging from ⅛" to ¾" in thickness.

NEW ROLLER-HEAD EXTRUDER

produces heavy-gauge sheet stock free of blisters and scorching

Typical of the specialized machines built by Farrel-Birmingham is this newly-designed extruder-calender combination. Used in the production of slab material, such as rubber sole and heel stock, it consists of an 8½" extruder with a slot head that feeds directly into the bank of a 16" x 42" two-roll calender.

The first few installations of this unit have been highly successful. Gone are the back flow and resultant increased stock temperatures associated with conventional machines used in this type of extrusion. The Farrel unit features a roller-head die or calender rolls, which can be cooled as required. Pulling action of the rolls and minimum restriction offered by the extruder die also reduce heat build-up within the stock.

The calender, which has a crossed-axes device for close gauge control, moves to and from the extruder on a sliding base. To increase the versatility of the combination, both the calender and extruder have adjustable-speed drives.

Ask for quotations on special extruders to meet your requirements.

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ANSONIA, CONNECTICUT

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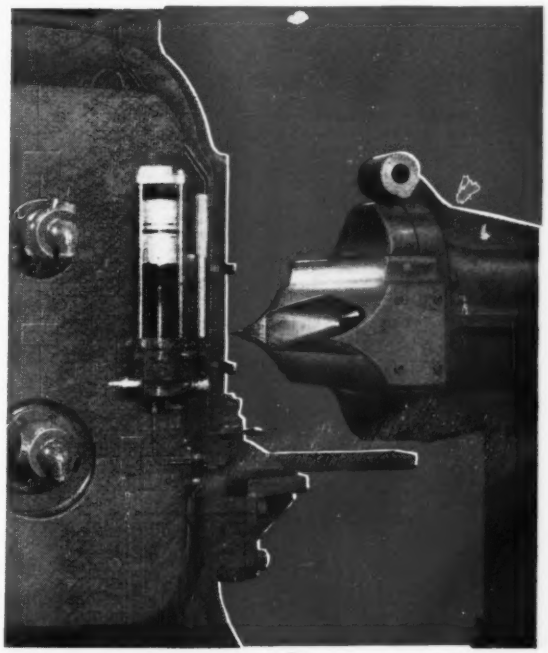

Close-up of the extruder head which feeds directly into the bite of the rolls.

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FB-1200

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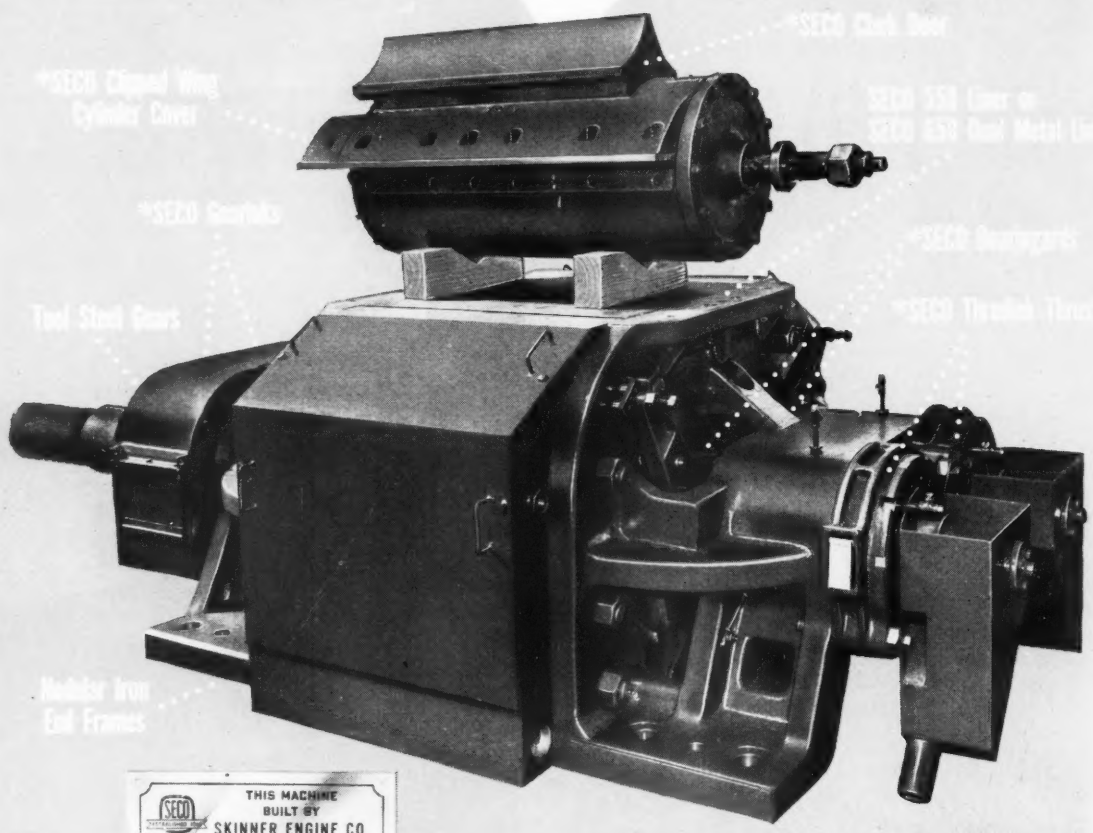

THIS MACHINE BUILT BY
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RUBBER MACHINERY DIVISION
ERIE PA.
DATE SERIAL NO

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CHEMI-VIC puts you on the right track against ozone attack!

The basic feature of new CHEMI-VIC is well described in the photograph above. That's CHEMI-VIC on the left, compared to a similar, currently popular elastomer, after 144 hours in an ozone box (100 pphm) at 100°F.

CHEMI-VIC is brand new—a vinyl reinforced nitrile elastomer. In addition to outstanding resistance to ozone and weather, it offers high physical properties plus exceptional resistance to oil. Moreover, it's easy to compound and process on standard equipment.

New CHEMI-VIC is available in two grades: CHEMI-VIC 400 for general purposes. CHEMI-VIC 800 for extrusion and calendering application. Typical uses: hose, belting, wire and cable jacketing, weather stripping, integral molded shoe soles. More information? Just write Goodyear, Chemical Division, Dept. X-9418, Akron 16, Ohio.

Lots of good things come from

GOODYEAR

CHEMICAL DIVISION

Chemi-Vic—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

Photograph taken with the cooperation of Rubbermaid Inc., Wooster, Ohio.

They're knee-deep in selling points—thanks to PLIOFLEX

A big problem in manufacturing rubber kneeling pads is getting the right physical properties—every time.

The best answer one leading manufacturer found was to use PLIOFLEX 1510. It makes possible a more uniform open-cell structure, better tear strength, and generally superior product quality—*batch after batch.* Just as important, PLIOFLEX 1510 reduces sticking and permits a lower temperature cure during molding. And uncured trim scrap can be effectively reworked, further cutting processing costs.

If you're looking for ways to improve your product—and profit-picture—look closely at PLIOFLEX 1510. For technical details on "1510," or for assistance with your specific problem, just write to Goodyear, Chemical Division, Dept. X-9418, Akron 16, Ohio.

Plioflex
light-colored styrene/butadiene rubber

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Plioflex—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

Photograph taken through the cooperation of Acushnet Process Company, New Bedford, Mass.

WING-STAY 100 checks the effects of oxygen—and ozone

It's no easy task to develop a good brake cylinder boot compound.

Part of the problem is the frequent flexing under exposure to hydraulic fluid and heat. But equally important are the effects of oxygen and ozone degradation.

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Why don't you look into the extra protection of WING-STAY 100? Full details, including the latest *Tech Book Bulletins*, are yours at Goodyear, Chemical Division, Dept. X-9418, Akron 16, Ohio.

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(Each unit 6 bags per layer, 7 layers high.)

Two units on right contain 96 bags—
2.4 tons Protox-267 zinc oxide.
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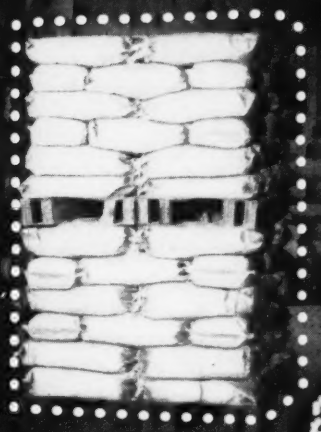
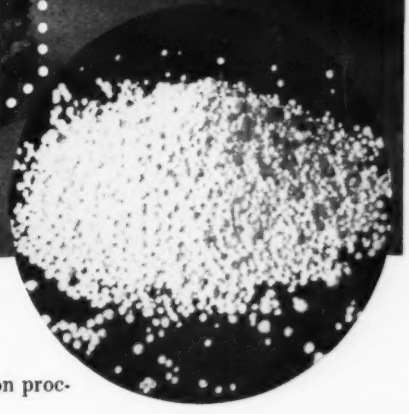


It's pelleted!



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PROTOX-267 bulks about half that of conventional zinc oxides. A 50-pound bag occupies less than 1 cubic foot of space. It flows freely . . . can be weighed out faster. Long before the pigment enters your processing operation you can start counting your savings.

But the most important savings come from PROTOX-267's faster incorporation and dispersion in rubber. The unique coating* of zinc propionate on the pigment particles makes for rapid and thorough dispersion. There are no aggregates . . . no undispersed pigment . . . no spotty cures.

And keep in mind . . . PROTOX-267 is a member of the HORSE HEAD line of zinc oxides. That also makes it the *most uniform* zinc oxide you can buy.

Do you have the 24-page booklet on PROTOX zinc oxides? It's chock-full of facts every rubber chemist and purchasing agent should know. A post card will bring you a copy.

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*U. S. Patent 2,303,330

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ROCKS ON THE RUN – In the making by The Port of New York Authority, the second traffic level on one of the world's most beautiful bridges, the graceful George Washington Bridge that joins the Jersey shore to Manhattan Island. The end result . . . beauty pointed skyward, begins with down-to-earth digging, upheaval of earth, removal of rocks, change of terrain. Contractors George M. Brewster & Co., Inc., responsible for a tremendous amount of the work being done on the New Jersey approach to the new level, estimated removal of approximately four hundred thousand yards of rock and one hundred fifty thousand yards of dirt on their contracts alone. New approaches to the bridge had to be cut from huge solid rock cliffs. Much of this rock was processed for re-use on the job as stone backfill, and as concrete aggregate. Thirty-six-inch belts were used to convey the rock from processing plants to hoppers. The belts for this huge operation were made for George M. Brewster & Co., Inc. by Hewitt-Robins, the carcasses of which were made with Mount Vernon fabrics.

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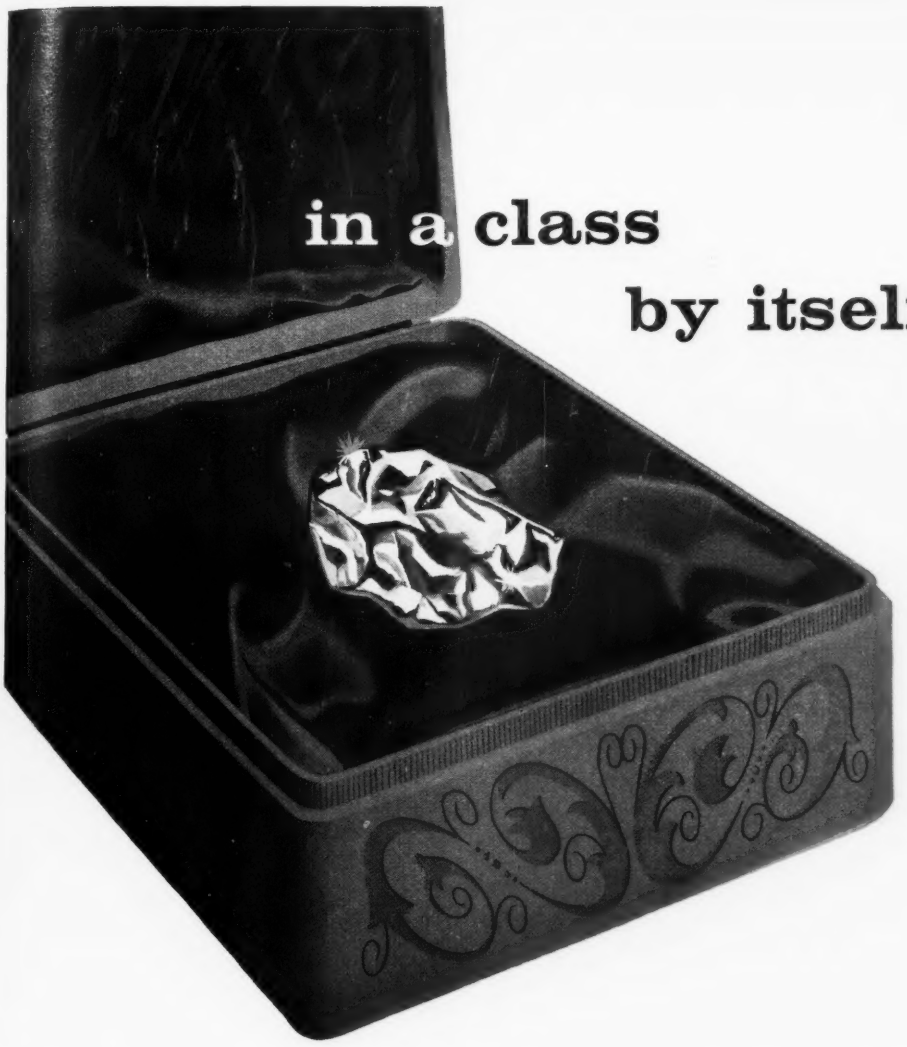

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Rubber and plastic products bring smiles to the kitchen. And TITANOX white titanium dioxide pigments, in turn, bring smiles to compounders and processors of all types of rubber and plastics.

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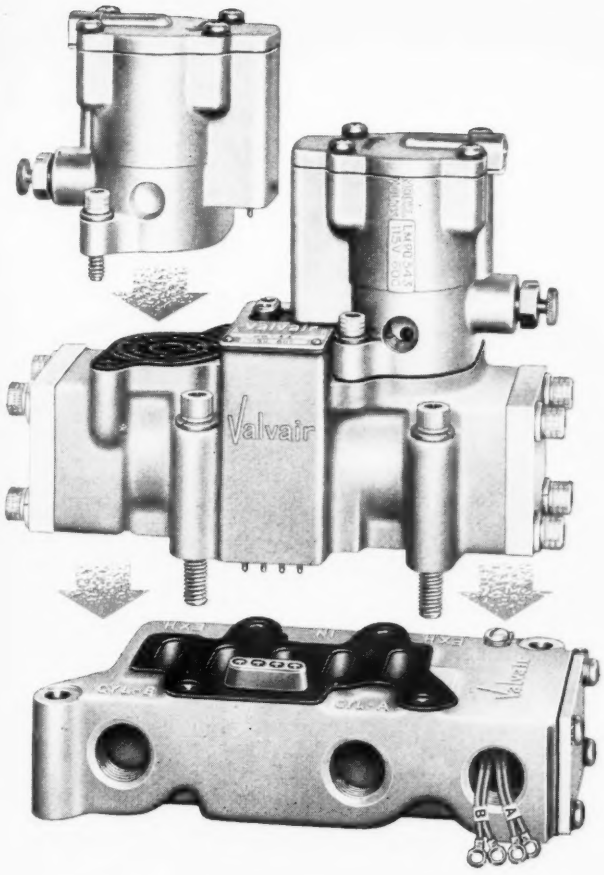

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MODEL PD-441 shown. 4-way single or double pilot-operated types, for sub-base or manifold mounting. Aluminum and stainless steel components assure multi-million cycle dependability. Interchangeable pilots, with coils guaranteed against burn-out for life of valve, fit any plug-in Speed King. Coils for ac or dc, any voltage . . . 35 — 200 psi range . . . integral junction box . . . optional manual over-ride, common or separate exhaust ports, sub-base connected external pilot supply . . . ¾ in. exhaust ports, ½ or ¾ in. inlet and cylinder ports . . . valve meets JIC standards.

Based on the service-proved design principle of the Speed King ¼ in. plug-in Valvair's ½ - ¾ in. plug-in valve series provides plug-in convenience and versatility to a wider range of control valve applications.

Electrical and pneumatic circuits are completed automatically when valve and pilot are plugged in . . . bolted down. The result — cost-cutting reduction of original installation and maintenance time. All power connections are made permanently in sub-base or manifold . . . there's no need to disturb piping or wiring for quick in-service maintenance.

What's more, advanced design shortens stroke . . . speeds response. Separate coded (4-wire) circuits on double solenoid models meet JIC requirements. Flow area through valve and sub-base equals that of full ½ in. pipe.

Whether your control valve applications are on the drawing board or now in service, it'll pay you to investigate the advantages of Valvair plug-in design. A call to your near-by Valvair field office will bring prompt application engineering recommendations.

For more information, write for Bulletin SPL. Address Dept. RW-1260, Bellows-Valvair, Akron 9, Ohio

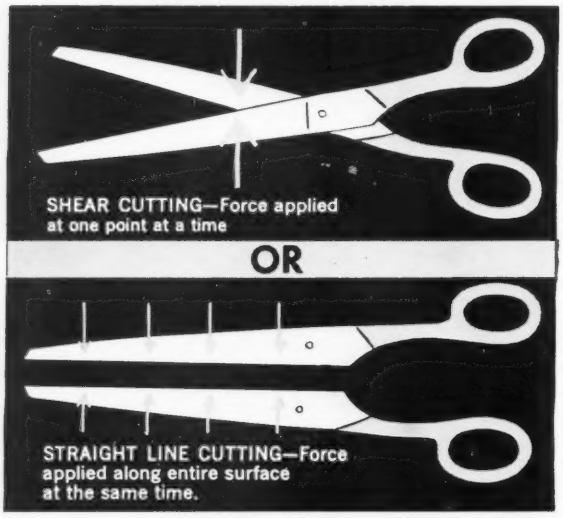
8098-3

Bellows-Valvair

AKRON 9, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

WHICH CUTTING METHOD IS MORE EFFICIENT?


SHEAR CUTTING—Force applied at one point at a time
OR
STRAIGHT LINE CUTTING—Force applied along entire surface at the same time.

TAYLOR-STILES CUTTERS USE THE SHEAR CUTTING PRINCIPLE

In Taylor-Stiles machines the cutting is concentrated at one point at a time (as shown in the top diagram), thus exerting tremendous "leverage", saving power and lengthening knife life. In straight line cutting, the impact is along the entire length at the same time requiring much more power and dulling knives much faster. All Taylor-Stiles GIANT Cutters use the shear cutting principle, the most efficient cutting method known. In some cases, savings in power consumption alone have paid for the machine in several years. In addition, initial cost is usually much less since smaller machines and motors are required. Simple bevel edge sharpening of knives, plus the fact that they stay sharp longer, means less down time.

Where crushing or tearing methods of stock reduction have been in use, Taylor-Stiles Cutters can save up to 90% of the operating expense. Cutting often does in one operation what it requires repeated reductions to accomplish in other methods, thus saving considerable time. Cutting produces a much more uniform product effecting further savings in container size and product handling.

If you have a stock reduction problem, contact Taylor-Stiles engineers. If our machines are not the type of equipment you need, we will say so. If they are applicable, we know you will find none other as efficient and economical. Ask about our free sample cutting services, too!

Cutterhead detail shows the shear cutting angle of the fly knife as it comes in contact with the bed knife.

TAYLOR, STILES & COMPANY

RIEGELSVILLE, NEW JERSEY, U.S.A.

INDUSTRIAL CUTTING EQUIPMENT FOR PLASTICS, RUBBER, TEXTILE, PAPER AND OTHER INDUSTRIES; MACHINERY FOR BALE OPENING

☐ I would like more information on your free sample cutting services.
☐ I would like more information on your rubber cutters.

NAME_____ TITLE_____

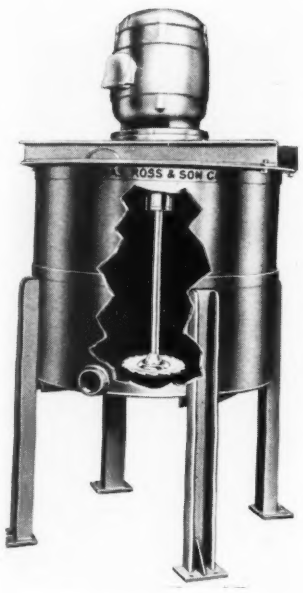
COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

new equipment

■



Ross stationary tank high-speed disperser

High-Speed Disperser

A new stationary tank disperser has been introduced by Charles Ross & Son Co., Brooklyn, N. Y., in sizes ranging from 5 to 3,000 gallons. The impeller and shaft operate at speeds up to 5,000 rpm., developing high impact and shear, which are reported to mix and disperse paste products in less time than many other stationary tank mixers.

Units feature impellers of either sawtooth disk type or with closed design multiple-action millhead. Both impeller and shaft are of stainless steel. Tanks are provided either plain or jacketed, with legs to raise outlet gate to any required height above floor. Several types of outlet gates can be supplied.

Automatic Integrator

The Model PX590 or PX591 electronic integrator, a new instrument for automatic integration of test data presented by any standard servo-drive recorder, has been introduced by Ridgefield Instrument Group, Schlumberger Well Surveying Corp., Ridgefield, Conn.

Providing a permanent, easy to read, analog record of test data, the integrator-recorder hookup reads out the integral signal on demand with an accuracy of 0.25% of full scale. The integral is read back into the recorder itself when integration is completed.

When the operator judges that the original data

(Continued on page 23)

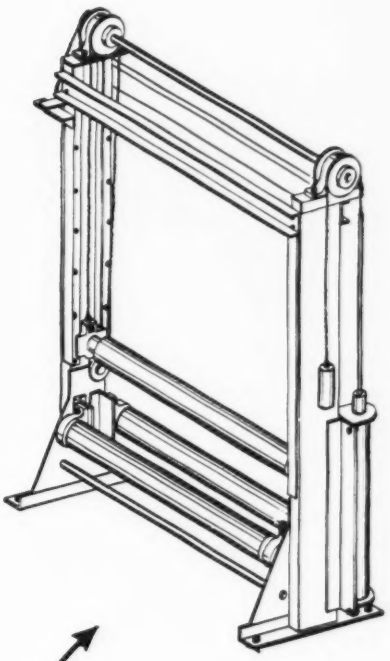
TIRE FABRIC PROCESSING EQUIPMENT

COMPENSATOR DANCERS

DESIGNED FOR ANY FABRIC TENSION RANGE
MAXIMUM ROLL DEFLECTION OF .010"
SIMPLE, RUGGED CONSTRUCTION

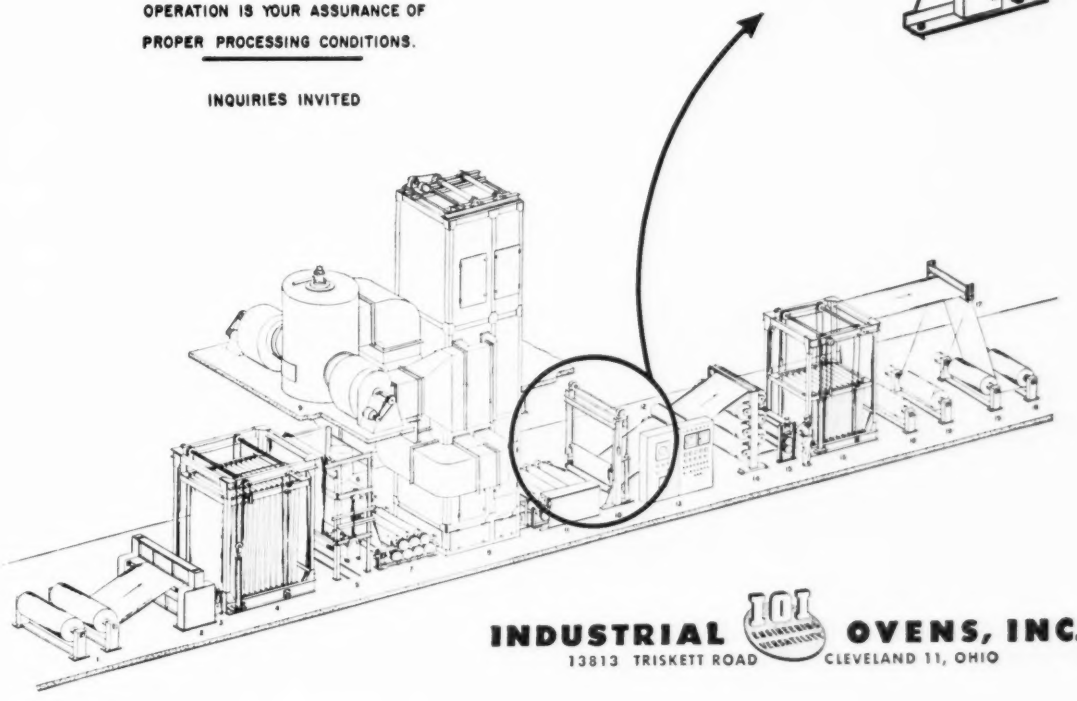
COUNTERBALANCED BY WEIGHT, AIR OR HYDRAULIC
SYMMETRICALLY LOADED TO PREVENT TWISTING
STANDARD AND INVERTED TYPES

SINGLE OR MULTIPLE ROLL TO PROVIDE
ADEQUATE CONTROL CAPACITY



THE RELIABILITY OF THE MANY I.O.I. DANCER UNITS IN CONTINUOUS LINE OPERATION IS YOUR ASSURANCE OF PROPER PROCESSING CONDITIONS.

INQUIRIES INVITED



INDUSTRIAL OVENS, INC.
13813 TRISKETT ROAD CLEVELAND 11, OHIO

THIS MAN KNOWS RUBBER

It's a long way from Chicopee Falls, Massachusetts, to Singapore and back, but Copolymer's Northeastern Area Sales Representative *ARTHUR E. BAILEY* made the trip in the course of his rubber industry career. His years of widely varied experience equip him with a wealth of invaluable information and seasoned know-how—his services have helped a lot of Copolymer customers find important "right answers" to rubber utilization questions. If you use rubber, Mr. Bailey is a good man to know when there's a job to be done in the Northeast. He has offices in Philadelphia and Hartford, *he knows rubber,* and like all Copolymer men, he has a customer-minded, ready-to-serve outlook we believe you'll appreciate.

Copolymer

RUBBER & CHEMICAL CORPORATION

Phone: Elgin 5-5655 P. O. Box 2591, Baton Rouge, Louisiana

A. E. "Art" Bailey	Hartford, Connecticut CHapel 7-5731 / Philadelphia, Pennsylvania LOcust 3-4663
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B. G. Hutchison	Chicago, Illinois SKyline 6-0500
Grant Rickard	Atlanta, Georgia PLaza 3-1534
West Coast Sales Agent:	
B. E. Dougherty Company	Los Angeles, California MAdison 4-9511 / San Francisco, California YUkon 6-5493

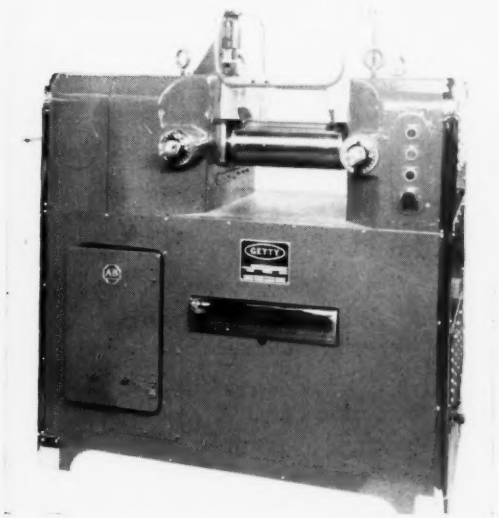
new equipment

(Continued from page 20)

have been completely recorded, a spring return switch is used to connect the integrator output to the recorder. A time delay relay causes the recorder to display the integrator value. The integrator is then reset automatically, and the pen returned to zero for the next integration.

A manual reset switch permits the operator to reset the integrator at will and to erase defective data.

The fastest integrating time normally used is six seconds to integrate full-scale sustained input to full-scale output. On a 10-inch-wide strip-chart moving at one inch a minute, read out acuracy is equivalent to 0.004-square inch of input. The gain selected has 10 steps, accurate to 0.1% over a 1000:1 range.



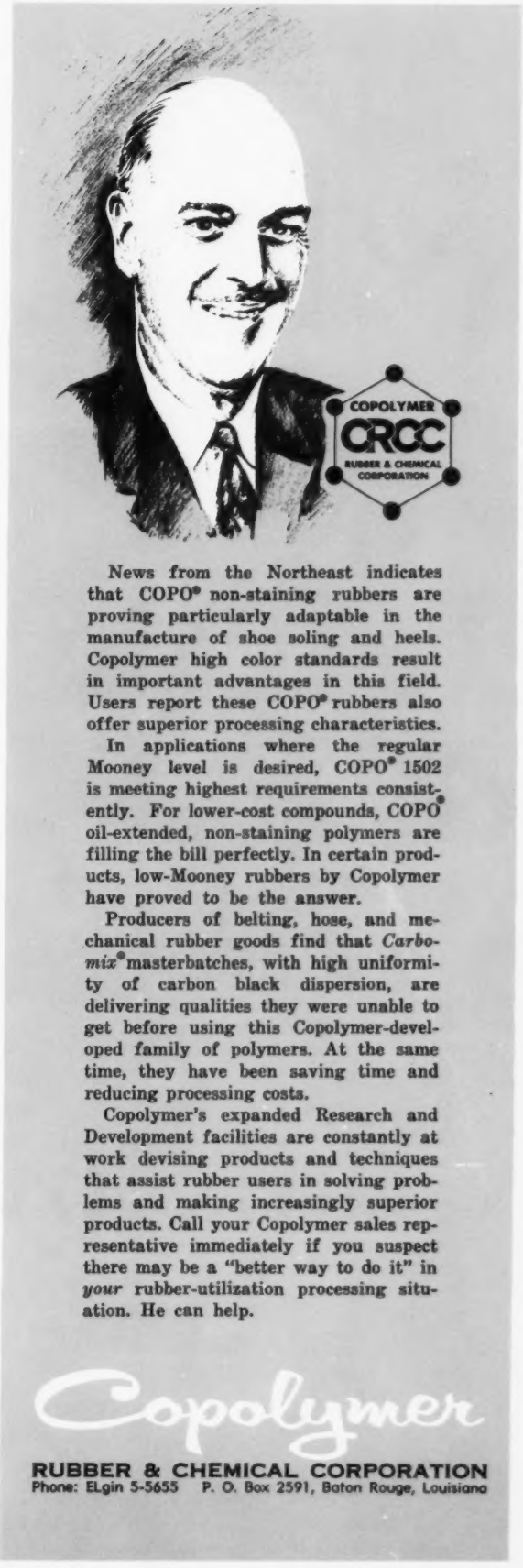
Getty Model 48-10½ laboratory mill

Laboratory Mills

Getty Machine & Mold, Inc., Clifton, N. J., has incorporated National Bureau of Standards recommended rolls on its Model 48-10½ laboratory mills, now on the market.

The heating medium is circulated in channels drilled close to the roll surface, and the front roll is fitted with a thermocouple ¼-inch below the surface, permitting a permanent record of the temperature of the experiment being conducted. The mill can also be supplied with a proportioning recording controller, which both controls and records the temperature of the rolls.

The mill is equipped with both knee-action and rocker-arm safety device, and a choice of either dynamic or magnetic braking is offered.



News from the Northeast indicates that COPO® non-staining rubbers are proving particularly adaptable in the manufacture of shoe soling and heels. Copolymer high color standards result in important advantages in this field. Users report these COPO® rubbers also offer superior processing characteristics.

In applications where the regular Mooney level is desired, COPO® 1502 is meeting highest requirements consistently. For lower-cost compounds, COPO® oil-extended, non-staining polymers are filling the bill perfectly. In certain products, low-Mooney rubbers by Copolymer have proved to be the answer.

Producers of belting, hose, and mechanical rubber goods find that *Carbomix*® masterbatches, with high uniformity of carbon black dispersion, are delivering qualities they were unable to get before using this Copolymer-developed family of polymers. At the same time, they have been saving time and reducing processing costs.

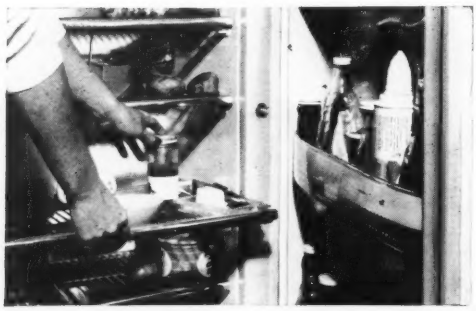
Copolymer's expanded Research and Development facilities are constantly at work devising products and techniques that assist rubber users in solving problems and making increasingly superior products. Call your Copolymer sales representative immediately if you suspect there may be a "better way to do it" in *your* rubber-utilization processing situation. He can help.

Copolymer

RUBBER & CHEMICAL CORPORATION
Phone: ELgin 5-5655 P. O. Box 2591, Baton Rouge, Louisiana

HARFLEX 330

POLYMERIC PLASTICIZER

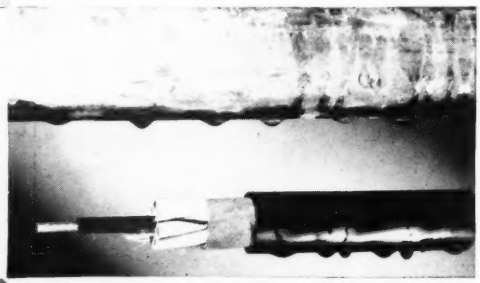


NEW FREEDOM FROM TASTE AND ODOR TRANSFER

Harflex 330 contributes to freedom from objectionable high taste and odor transfer to food from refrigerator gaskets.

NEW FREEDOM FROM HIGH HEAT AND HUMIDITY SPEW

Harflex 330 features good electric properties, including high dielectric strength both dry and after immersion in water, plus rugged resistance to copper corrosion



NEW FREEDOM FROM VINYL UPHOLSTERY PROBLEMS

Harflex 330 imparts durability and permanent flexibility to vinyls despite their subjection to perspiration, oil, soil, frequent washing with soapy water or chlorinated solvents, humidity, heat and sunlight.

Columbian Carbon Company, Distributor To The Rubber Industry

SEBACATES
PHTHALATES
ADIPATES

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HARCHEM DIVISION

WALLACE & TIERNAN, INC.
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IN CANADA: HARCHEM LIMITED, TORONTO

Write for Sample and Bulletin
or see Chemical Materials Catalog - Pages 173-175.

means clean, bright, new

is eye appeal

says "buy me"

GLIDDEN ZOPAQUE®
TITANIUM DIOXIDE

Gone are the days of rejected merchandise because of yellowing on the shelves, fading and other "appearance failures." Glidden *Zopaque* Titanium Dioxide assures *certain* optical qualities: high opacity, hiding strength and tinting power.

Let Glidden *Zopaque* help you make your product (easily dispersible in rubber compounding) and sell your product through clean, bright, new, "BUY ME" eye appeal!

Write or call for complete information.

QUALITY Glidden PRODUCTS

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Chemicals Division • Pigments and Color Department
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(This advertisement is printed on paper stock containing Glidden *Zopaque* Titanium Dioxide.)

WHAT CORD?
WHAT TREATMENT?

Ask your **Computreater**

Over thirty of these precision laboratory units are in use throughout the world . . . establishing tire cord standards, cord impregnation and heating process data for leading tire and fibre producers everywhere . . . technical data on request.

C. A. LITZLER CO., INC.

SOUND ENGINEERING FOR TOMORROW'S PRODUCTION

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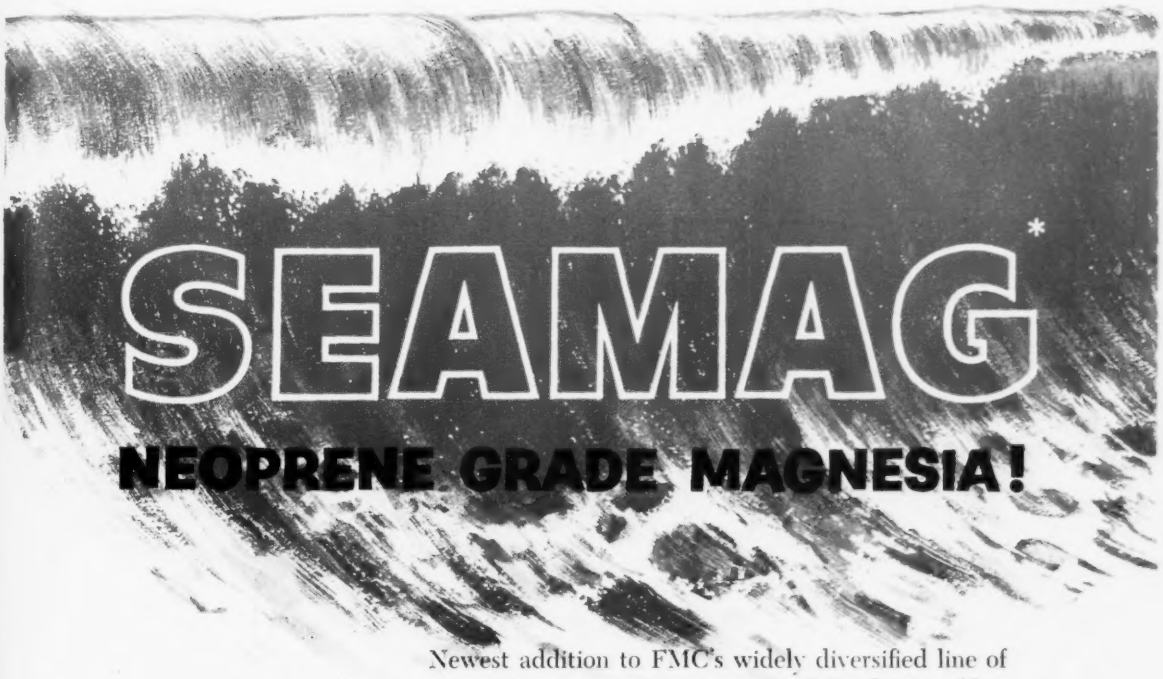
LICENSED FABRICATORS: Benno Schilde Maschinenbau A. G. Bad Hersfeld, Germany · Soc. Alsacienne de Constructions Mecaniques Paris, France · Mather & Platt, Ltd. Manchester, England

Now! another cost-cutting *fmc* development



Newest addition to FMC's widely diversified line of magnesias . . . gives neoprene and synthetic rubber compounders these advantages:

High bulk density!
To work into the batch more readily.

Finer particle size!
To provide better dispersion and distribution throughout the batch.

High adsorptive capacity!
For excellent anti-scorch properties.

Economical!
Produced by an exclusive FMC process! Amply available at an attractive price.

Samples and data on request!

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Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

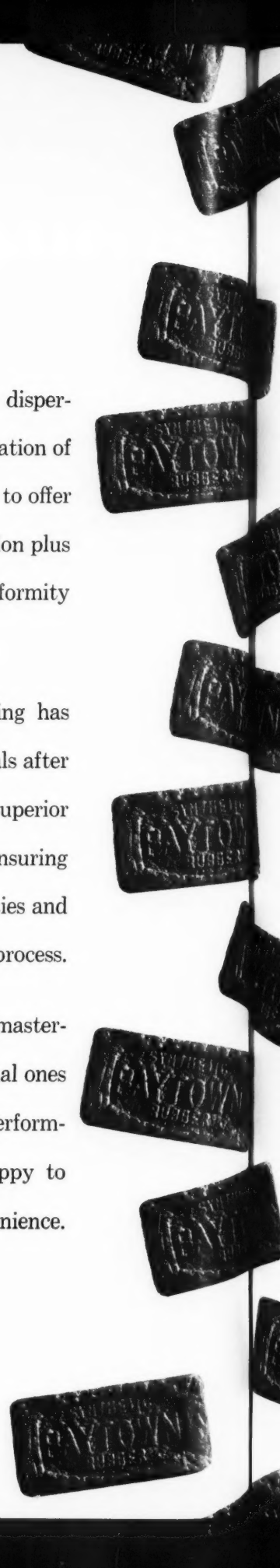
Mineral Products Division

General Sales Offices:
161 E. 42nd STREET, NEW YORK 17

The uniquely different dispersant-free carbon black/SBR dispersion technique and UNITED-BARCLAY non-brine coagulation of the black masterbatch latex (patents applied for) combine to offer improved end-product performance, fast mixing and extrusion plus traditional handling ease historically associated with the uniformity of BAYTOWN black masterbatches.

Service Laboratory and standard commercial compounding has shown that less residual nerve remains in these new materials after mixing on conventional Banbury cycles. Fast curing and superior tensile strengths have been recorded. Extremely low ash ensuring such desirable characteristics as improved electrical properties and lower moisture absorption result from the new coagulation process.

Today there are 17 new dispersant-free BAYTOWN black masterbatches to serve you. These masterbatches and the additional ones now scheduled for full-scale commercial production have a performance potential that merit your review. We would be happy to make available samples for processing review at your convenience.



A Reference Guide To The New Baytown Dispersant-Free Black Masterbatches

BAYTOWN 1808
100 parts SBR polymer
75 parts HAF black
37.5 parts highly aromatic extending oil
12.5 parts highly aromatic processing oil
mixed/staining

BAYTOWN 1811
100 parts SBR polymer
75 parts SRF black
17.5 parts highly aromatic processing oil
rosin/staining

BAYTOWN 8675
100 parts SBR polymer
50 parts HAF black
9 parts naphthenic processing oil
rosin/staining

BAYTOWN 8676
100 parts SBR polymer
50 parts ISAF black
10 parts aromatic processing oil
rosin/staining

BAYTOWN 8677
100 parts SBR polymer
52 parts HAF black
10 parts highly aromatic processing oil
rosin/staining

BAYTOWN 8678
100 parts SBR polymer
40 parts SAF black
5 parts highly aromatic processing oil
rosin/staining

BAYTOWN 8679
100 part SBR polymer
40 parts SAF black
10 parts highly aromatic processing oil
rosin/staining

BAYTOWN 8680
100 parts SBR polymer
52 parts HAF black
15 parts highly aromatic processing oil
rosin/staining

BAYTOWN 8681
100 parts SBR polymer
50 parts ISAF black
15 parts highly aromatic processing oil
rosin/staining

BAYTOWN 8775
100 parts SBR polymer
75 parts HAF black
37.5 parts aromatic extending oil
mixed/staining

BAYTOWN 8776
100 parts SBR polymer
50 parts HAF black
37.5 parts naphthenic extending oil
mixed/non-staining

BAYTOWN 8777
100 parts SBR polymer
75 parts HAF black
37.5 parts naphthenic extending oil
mixed/non-staining

BAYTOWN 8779
100 parts SBR polymer
75 parts HAF black
37.5 parts naphthenic extending oil
12.5 parts naphthenic processing oil
mixed/non-staining

BAYTOWN 8780
100 parts SBR polymer
71.5 parts HAF black
51.25 parts aromatic extending oil
mixed/staining

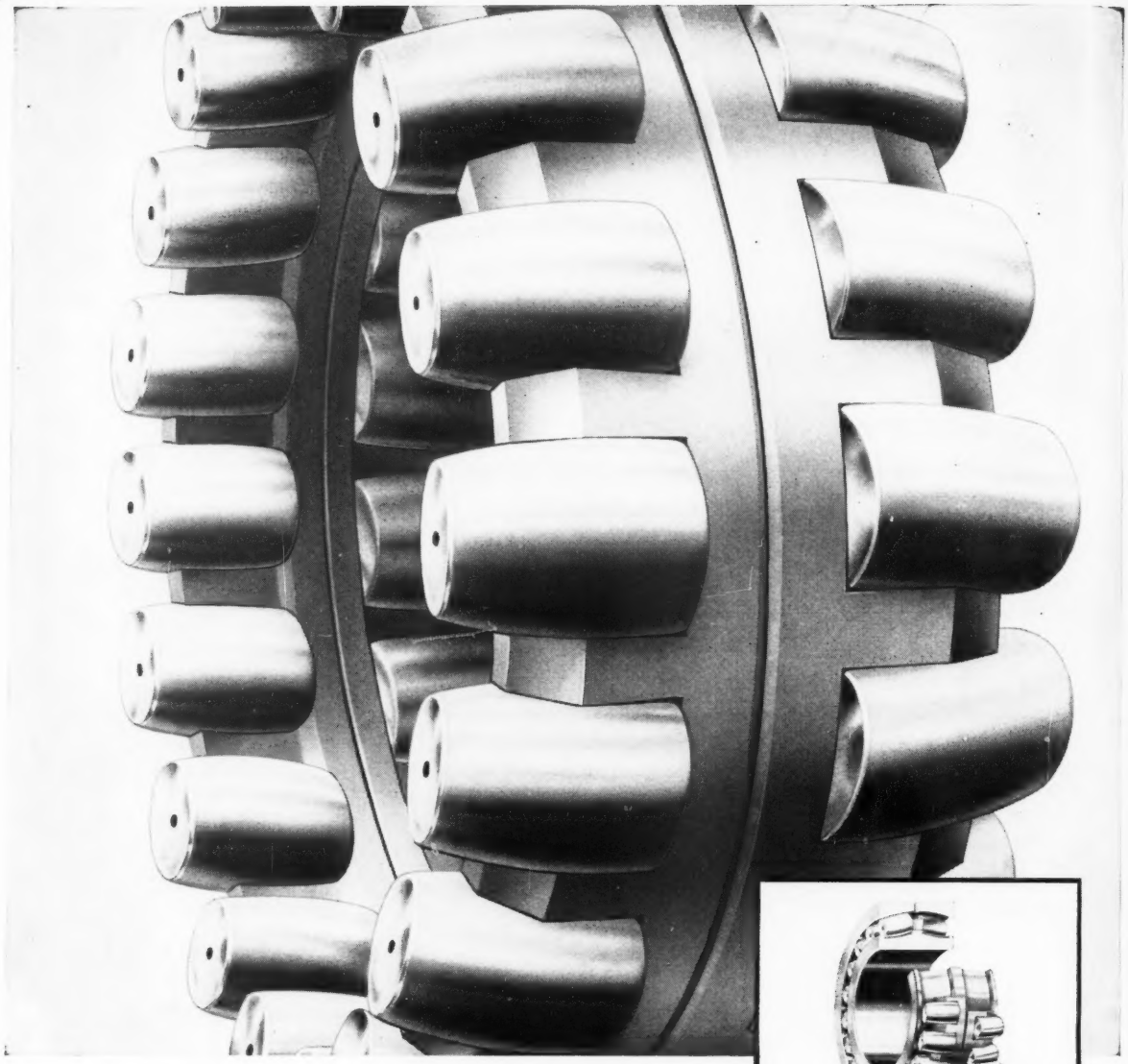
BAYTOWN 8781
100 parts SBR polymer
55 parts ISAF black
37.5 parts aromatic extending oil
mixed/staining

BAYTOWN 8782
100 parts SBR polymer
68.75 parts FEF black
37.5 parts naphthenic extending oil
mixed/non-staining

BAYTOWN 8783
100 parts SBR polymer
80 parts FEF black
37.5 parts naphthenic extending oil
mixed/non-staining

UNITED CARBON COMPANY, INC.
410 PARK AVENUE, NEW YORK 22, N. Y.
A Subsidiary of United Carbon Company
AKRON CHICAGO LOS ANGELES
BOSTON HOUSTON MEMPHIS
In Canada: CANADIAN INDUSTRIES LIMITED

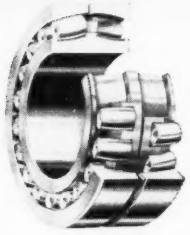
UNITED CARBON



"Caged" for Longer Life!

The two land-riding cages in Torrington Spherical Roller Bearings assure proper roller spacing and guidance, even under rugged conditions of shock load and sustained high speeds. These fully machined cast bronze cages operate independently. Their design eliminates drag on rollers. These high-strength cages help bearings give longer life by providing low friction, smooth running and cool operation. Highly effective and generous lubrication of all contact surfaces is achieved with the open-end cage design.

The result: Torrington Spherical Roller Bearings are built to give extra years of unmatched service life in heavy-duty applications. Torrington's long experience in design, engineering and manufacture of every basic type of anti-friction bearing provides the finest spherical roller bearings available. You'll find it pays to standardize on Torrington.



Superior design features of TORRINGTON SPHERICAL ROLLER BEARINGS

- integral guide flange for roller stability
- asymmetrical rollers seek flange for positive guidance
- electronically matched rollers
- size-stabilized races
- fully machined land-riding bronze cages
- controlled internal clearances
- even load distribution
- inherent self-alignment
- long service life

progress through precision **TORRINGTON BEARINGS**

THE TORRINGTON COMPANY South Bend 21, Indiana • Torrington, Conn.

IMPROVED

"ROBOT BRAIN"

works faster, more precisely!

Taylor FLEX-O-TIMER® Controller gives:

- *Up to 12 pneumatic and/or electric functions*
- *Faster, easier setting of Program Trip Pins*
- *Positive acting air valves with more than 3 times previous output capacity*

Recognized for many years as a highly versatile "robot brain" for the precise timing and coordination of batch processes, this new FLEX-O-TIMER Timed Program Controller has been made even more simple to operate, more precise in its control. It is ideal for providing completely automatic time control for tire presses, particularly for nylon cord tires requiring additional functions; platen presses; or any process requiring precise timing of process sequence and duration involving temperature, pressure, mechanical motion, electrical energy, or any combination thereof.

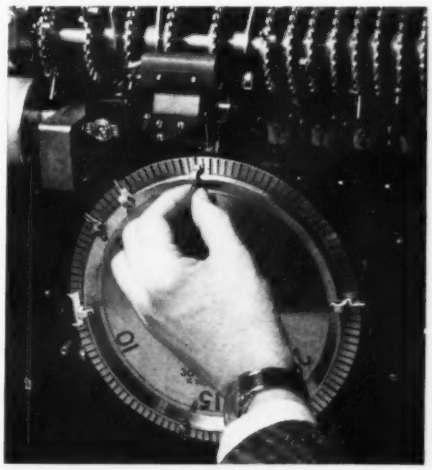
As well as the three major improvements listed above, the new FLEX-O-TIMER Controller incorporates these plus features:

- Extremely short time intervals between steps (with high accuracy) can be accommodated . . . 7½ seconds on 30 minute cycle dial; minimums on other dials in same ratio.
- Cycle range is quickly adjustable for 15 to 60 minutes for highspeed range. 1 to 16 hours for low-speed range.
- Time dial automatically resets to zero in maximum of 13 seconds at completion of cycle.

* * *

Ask your Taylor Field Engineer for full details or write for **Bulletin 98373.**
Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ont.

The 350R Series FLEX-O-TIMER Timed Program Controlled actuates switches, valves, performs other operations at the proper time and in proper sequence.



Program Trip Pins are simply placed at selected intervals, set screws tightened with an Allen wrench.

Step Cams fit snugly into step disc notches, are easily bolted into place, never have to be adjusted.

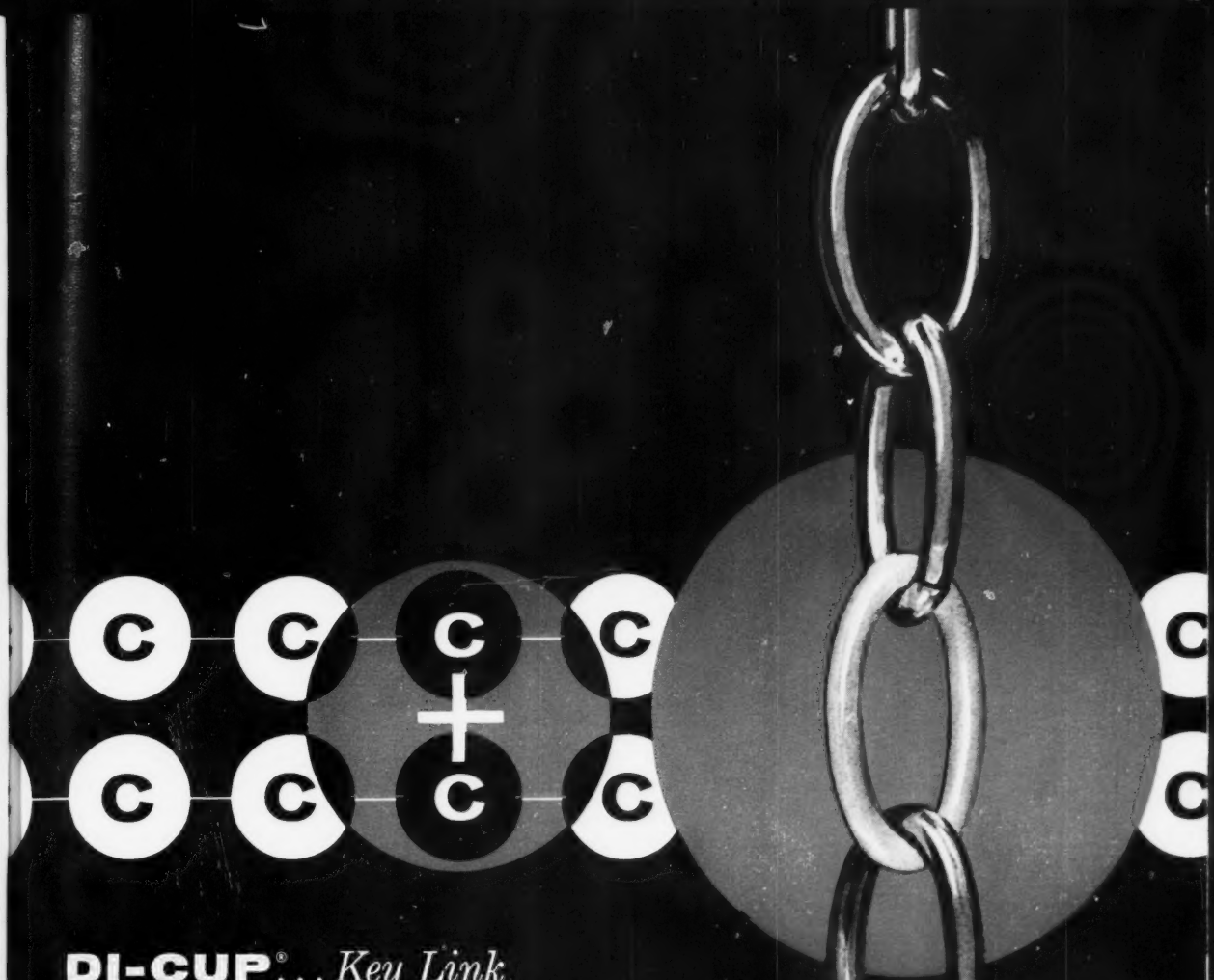
Taylor Instruments **MEAN ACCURACY FIRST**

PREVENT CRIPPLING DISEASES

MARCH OF DIMES

THE NEW MARCH OF DIMES
NF
THE NATIONAL FOUNDATION

BIRTH DEFECTS · ARTHRITIS · POLIO



DI-CUP®... *Key Link in Cross-Linking Polyethylene*

Di-cup, Hercules dicumyl peroxide, is a source of free radicals, which are highly effective in chemical cross-linking. It provides a simple, economical, and practical means of cross-linking low-density polyethylene.

Cross-linked polyethylene is a thermoset material resistant to softening and deformation at high temperatures. It shows no evidence of environmental stress cracking and it is resistant to many solvents at high temperatures.

This development opens new markets for products that require superior toughness, flexibility, impact strength, and chemical resistance.

For more information on Di-cup, write

Oxychemicals Division
Naval Stores Department
HERCULES POWDER COMPANY
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910 Market Street, Wilmington 99, Delaware

N060-4

The only explanation I have is that he must be in the neoprene business— and knows that MAGLITE is the key to superior scorch protection.

Maglite®

The performance-proved magnesium oxide

Want to eliminate scorch damage in neoprene processing? Specify MAGLITE D. Tests prove that it offers better scorch protection for neoprene than any other magnesium oxide you can use. MAGLITE D also helps solve storage problems since it occupies about one-third the warehouse space as many of the lightweight magnesias. The benefits of using MAGLITE K, M, or Y for other elastomers and certain product or process requirements are equally impressive. For samples and technical information write to

MERCK MARINE MAGNESIUM DIVISION

MERCK & CO., INC. • RAHWAY, N.J.

DISTRIBUTORS:

THE C. P. HALL CO. • WHITTAKER, CLARK & DANIELS, INC.

new materials

Gafac Anionic Surfactants

Antara Chemicals Division, General Aniline & Film Corp., New York, N. Y., is introducing a new series of surface active agents under the trade mark of Gafac. The products were designed for application in emulsion polymerization, textile use, heavy-duty liquid detergent compound, agriculture, and [illegible] cleaning.

[illegible] four products now available in the line, [illegible] PE510 and RE610, are recommended two, Ga[illegible]any for use in emulsion polymerization by the com[illegible]nomers such as NBR and SBR rubber of acrylate m[illegible]inyl-type emulsions. The company bers and other [illegible] with sulfonated anionic surfactants and a nonio[illegible]ic surfactant, the Gafac surfactants give film clarity[illegible]sion resistance, and low says that compare[illegible] light stability, heat stability, buffering action, cor[illegible] residual monomer contact.

Silicone Adhesive[illegible]

Improved Cohrlastic C-251, a silicone[illegible] rubber thermal curing cement for bonding silicone[illegible]ucts, has been developed by Connecticut Hard Ru[illegible]r Co., New Haven, Conn. The product is also use[illegible] for bonding silicone rubber to metal, plastics, gla[illegible] ceramics with the aid of Cohrlastic C-260 me[illegible] primer, the company says.

The product is said to have an effective temperature range from —100 to 500° F., a bond strength varying from 8 to 15 psi., peel strength depending on formulation, better handling, and quicker curing, as well as less sensitivity to adverse conditions of bonding.

Repairs with Epoxy

Plastic Steel, a modified epoxy composed of 80% powdered steel and 20% plastic, can be used for repairs to plant equipment when welding is unfeasible, Devcon Corp., Danvers, Mass., manufacturer of the product, reports.

The modified epoxy is mixed with hardener just before using. Applied with a putty knife, it cures without heat or pressure into a solid mass that can be machined. It is also used to make emergency and maintenance repairs on pumps, valves, piping, castings, and other industrial tools, the manufacturer adds.

(Continued on page 42)

This family's soled on Ameripol Rubber

The Gold Seal Rubber Company makes a variety of canvas rubber soled footwear. Here again Ameripol polymers are preferred because of their superior uniformity . . . well-known stability in processing and excellent physical properties.

A blend of Ameripol 1009 with other polymers results in compounds exhibiting low shrinkage during processing and curing—provides a smooth sheet stock. These compounds have excellent resistance to abrasion and flexing. Thus Ameripol solves the problems of both looking attractive and keeping the user satisfied despite rough wear and abuse.

Goodrich-Gulf produces the broadest range of synthetic rubber polymers in the industry. One of them may be just what you need to put your product a step ahead.

For thorough service contact Goodrich-Gulf Chemicals, Inc., 1717 East Ninth Street, Cleveland 14, Ohio.

Ameripol
THE PREFERRED RUBBER

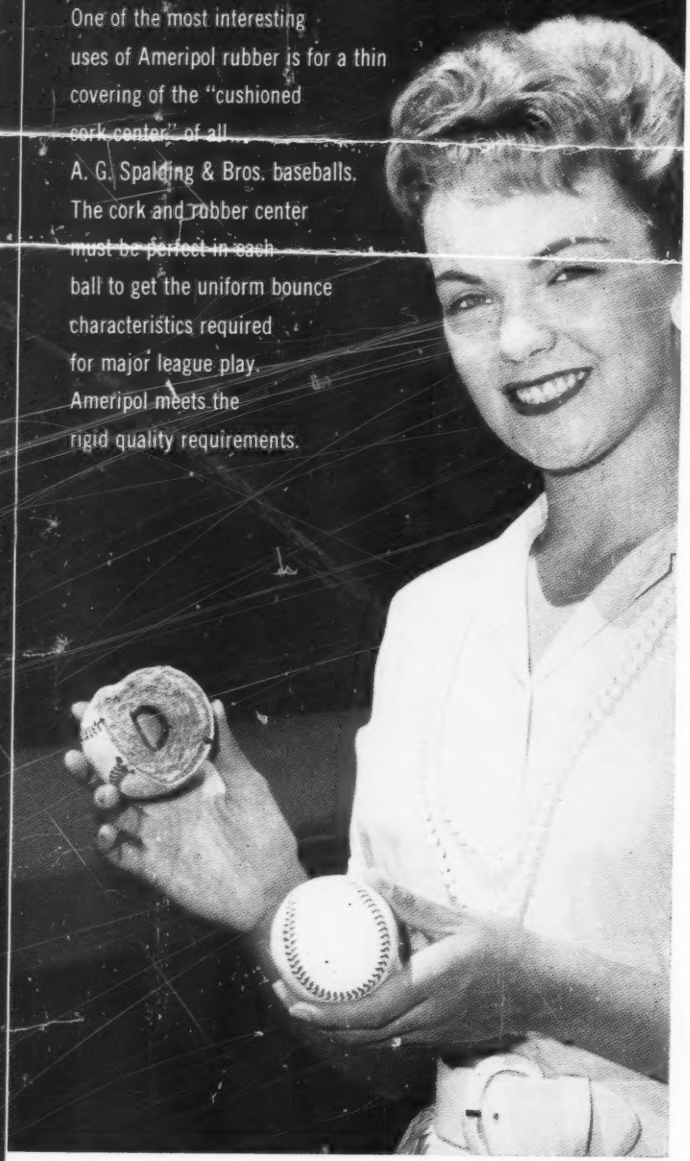
Goodrich-Gulf Chemicals, Inc.

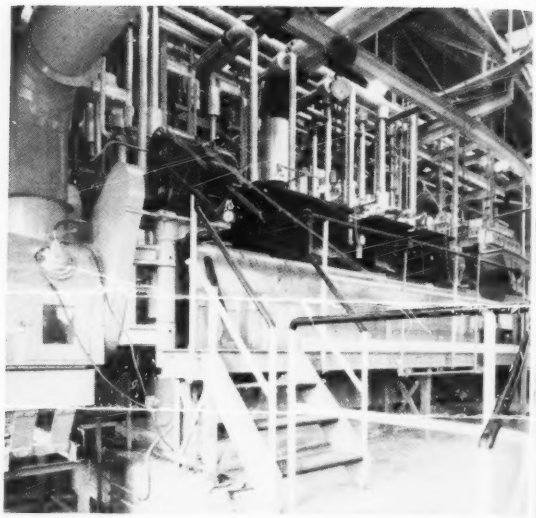
THE ONE TO WATCH FOR NEW DEVELOPMENTS

NEWS FROM GOODRICH-GULF

AMERIPOL FOR THE LONG BALL

One of the most interesting uses of Ameripol rubber is for a thin covering of the "cushioned cork center" of all A. G. Spalding & Bros. baseballs. The cork and rubber center must be perfect in each ball to get the uniform bounce characteristics required for major league play. Ameripol meets the rigid quality requirements.





HUGE MACHINE SETS FAST PACE IN SYNTHETIC RUBBER DRYING

This 40-foot long machine, at the Institute, West Virginia plant of Goodrich-Gulf, is the largest production-scale extrusion dryer in the industry. The machine drastically cuts drying time, also delivers a polymer free of moisture and with low ash content to improve product quality.

The extrusion dryer has a design capacity of 6000 to 8000 pounds per hour. Entire cycle time, from the time wet rubber enters the feed box until it passes through a pelletizing die, is 5 to 10 minutes. Development of this machine represents a major forward step in production of synthetic rubber.

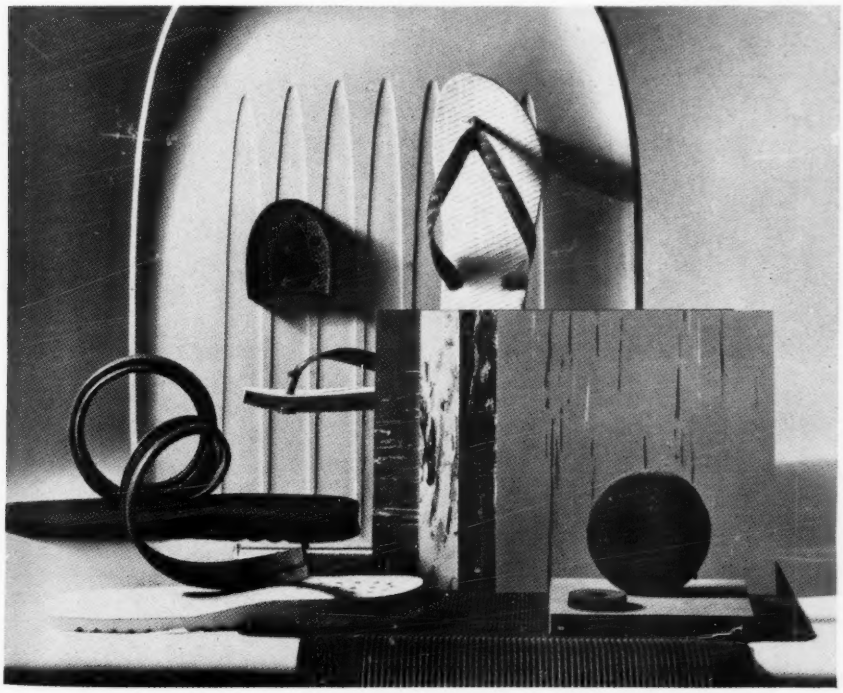
NEW AMERIPOL POLYMER EASIER TO PROCESS ...IMPROVES PRODUCT QUALITY

Ameripol 4601 is a new polymer designed with medium-low viscosity to enable the fabricator to reduce processing time and power costs, and to eliminate the need for costly peptizing agents. Physical properties compare favorably with those of a peptized high-viscosity polymer such as SBR 1502.

This polymer permits easier mixing, smoother calendering, faster extrusion. The polymer exhibits less shrinkage and improved smoothness and quality. The elimination of peptizing agents not only reduces cost, but avoids a possible source of discoloring.

For many types of rubber products including sponge, floor tile, soling and heels, mats, and extrusions, you can switch to Ameripol 4601 and obtain equal or improved physical properties, while reducing processing costs.

This new polymer is another result of Goodrich-Gulf's continuing product development program which can help you in fabrication or use of synthetic rubber polymers. Polymer evaluations and test data are available through Goodrich-Gulf Technical Service. Address: 1717 East Ninth Street, Cleveland 14, Ohio.



AMERIPOL 4601 has ideal qualities for many products

- Light Color
- Low Viscosity
- Good Physical Properties
- Low Water Absorption

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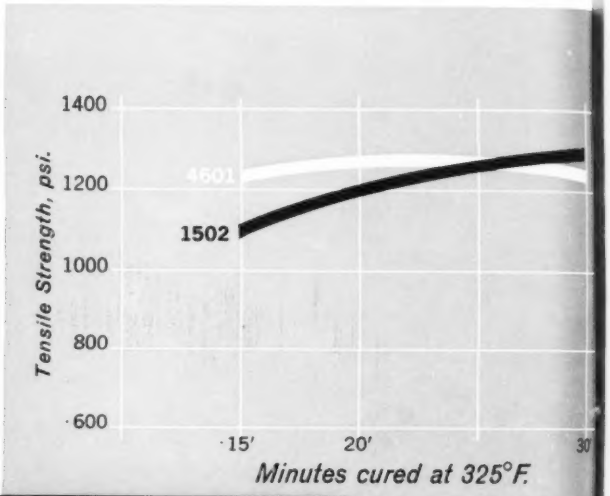
YOU CAN ECONOMIZE IN PROCESSING AMERIPOL 4601- AND OBTAIN EXCELLENT PHYSICAL PROPERTIES

Ameripol 4601 has been evaluated in the Goodrich-Gulf Sales Service Laboratory, with comparative tests t SBR 1502. Stocks compounded in the recipe below tested for various properties, as shown in graphical form

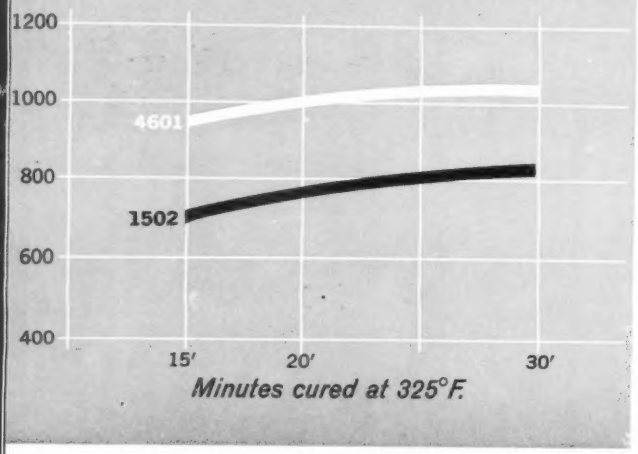
TYPICAL TILE TEST RECIPE	1502	4601
POLYMER	100.00	100.00
HIGH STYRENE RESIN	15.00	15.00
HARD CLAY	200.00	200.00
WHITING	125.00	125.00
ZINC OXIDE	5.00	5.00
COUMARONE-INDENE 100°C., M.P.	10.00	10.00
LIGHT PROCESS OIL	10.00	10.00
MBTS	1.50	1.50
TMTD	0.66	0.66
CRYSTEX SULFUR	4.00	4.00
TOTAL	471.16	471.16

GENERAL PROPERTIES		1502	4601
RAW VISCOSITY		53	38
COMPOUNDED VISCOSITY		121	108
MOONEY SCORCH T-3 @ 280°F.		5.9	7.0
SHORE A HARDNESS, CURE @ 310°F.			
	15′	89	89
	20′	89	89
	30′	89	89
ABRASION % STD. B., %	37.5	25.4	23.9
HEAT AGED			
70 HRS. @ 158°F.			
TENSILE, PSI	30′	1510	1350
ELONGATION, %	30′	210	120
100% MODULUS, PSI	30′	1130	1190
SHORE A HARDNESS	30′	92	92

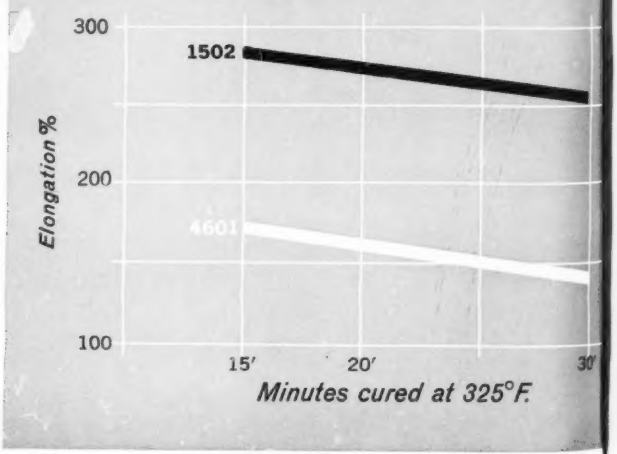


TENSILE STRENGTH

MODULUS



ELONGATION



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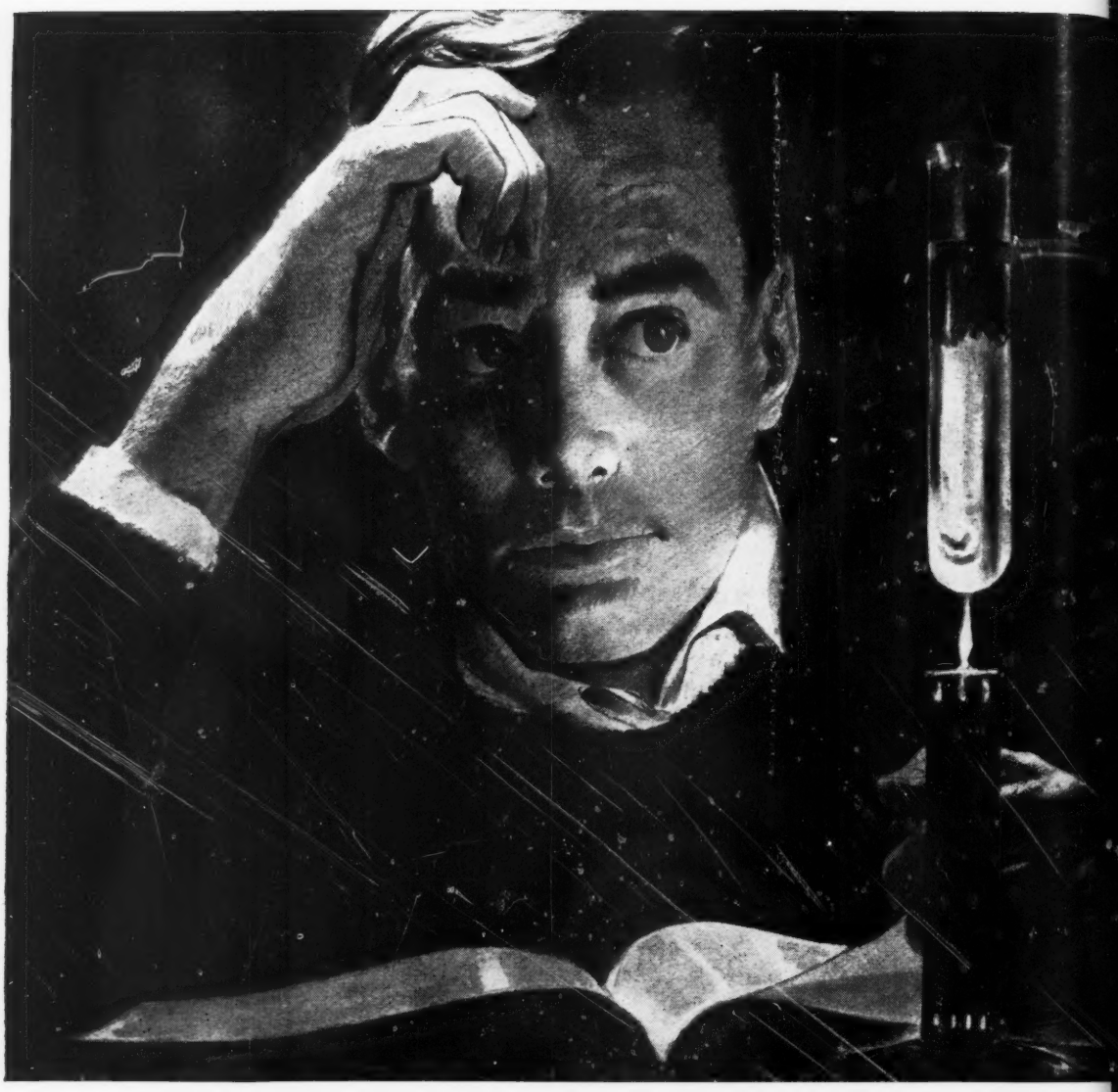

Helping Dreamers to Dream Keeps America Strong

"We are the music-makers,
And we are the dreamers of dreams . . .
Yet we are the movers and shakers
of the world forever, it seems."

Arthur O'Shaughnessy, The Music-Makers

Throughout our history as a nation—indeed, throughout the history of all mankind—it has been the dreamers of better ways of doing things who have made our lives more worthwhile.

And yet the dreamer of today, if he is to contribute to the betterment of his fellow man, must be an *educated* dreamer. He must have assimilated the knowledge and undergone the training that enable him to dream *beyond* the present, beyond the knowledge we have now.

Can there possibly be a better reason for strengthening the *sources* of knowledge—colleges and universities?

It seeems incredible that a society such as ours which has profited so vastly from an accumulation of knowledge—an from the fulfillment of dreams—should allow anything t threaten these wellsprings of our learning.

The crisis that confronts our colleges threatens to weake seriously their ability to transmit the knowledge and to en courage the dreams that will keep America strong.

The crisis is composed of several elements: a salary sca that is driving away from teaching the kind of person be *qualified* to teach; overcrowded classrooms; and mountin college applications that will *double* in less than ten years.

Help the colleges and universities of your choice. Hel them plan for stronger, better-paid faculties and for expan sion. The returns will be greater than you think.

If you want to know more about what the college crisis means to you, an what you can do to help, write for a free booklet to: HIGHER EDUCATION Box 36, Times Square Station, New York 36, N.Y.

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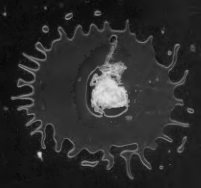

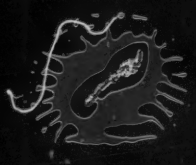

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new materials

(Continued from page 34)

Cited is the example of repairs made recently to the cracked water-jacket casing of an ammonia compressor in a brewery in Johannesburg, South Africa. A representative of Rance, Colly & Co., (Pty.) Ltd., which performed the repair, explained that welding was rejected because the metal would expand and contract under the heat of a torch, throwing the casting out of line. With the use of Plastic Steel the compressor was repaired while in operation at a cost of $11.20, saving $1,300 in labor and materials and the time that it would normally be out of operation while repairs were made, the engineering firm says.

Poro-Coat—Mold Release Agent

Chem-Trend, Brighton, Mich., is marketing a mold release agent specifically designed for flexible one-shot polyurethane foams. The product, Poro-Coat, is an extremely fine dispersion of waxes and resins. The product is very fluid, lending itself to application by spraying or brushing, yet does not separate on standing, the manufacturer claims. It is practically colorless and odorless.

The product is said to answer the problems of difficult release and formation of loose skin often found in production of one-shot foam, releasing the foam with no skin and a completely open-celled surface.

Nonionic Surfactants

Union Carbide Chemicals Co., New York, N. Y., has introduced five new nonionic surfactants which the company considers have possible application to latices. Three of the new surfactants, Tergitol nonionics 12-P-6, 12-P-9, and 12-P-12, are based on dodecyl phenol. Two, Tergitol nonionics TMN-3 and TMN-10, are based on trimethyl nonanol.

Tergitol 12-P-6, a dodecyl phenol adduct with 6 mols of ethylene oxide, is soluble in aromatic and aliphatic hydrocarbons and suitable for sulfation. Tergitol 12-P-9, a dodecyl phenol adduct with 9 mols of ethylene oxide, is soluble in aromatic hydrocarbons and can be used in place of nonyl phenol adducts containing 5 to 8 mols of ethylene oxide. Tergitol nonionic 12-P-12, a dodecyl phenol adduct with 12 mols of ethylene oxide, is a completely water soluble nonionic.

Tergitol TMN-3, a trimethyl nonanol adduct with 3 mols of ethylene oxide, is soluble in aromatic hydrocarbons and slightly soluble in aliphatic hydrocarbons and mineral oil. Tergitol TMN-10 is a completely water soluble trimethyl nonanol adduct with 10 mols of ethylene oxide.

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Benzidine Yellows				
Pigment Yellow			■	■
Permagen® Yellow	■	■	■	■
Permanent Yellow		■	■	■
Benzidine Orange				
Permagen Orange		■	■	■
Dianisidine Orange				
Permagen Orange		■	■	■
Permanent Red	■		■	
BON Reds				
Permagen Red		■	■	■
Dioxazine				
Permanent Violet	■	■	■	■
Naphthols				
Helio® Red		■	■	
Naphthol Red		■	■	
Permanent Red	■	■	■	■
Permanent Carmine	■	■	■	■
Parachlor Red				
Pigment Red	■		■	
Phthalocyanines				
Heliogen® Blue	■	■	■	■
Heliogen Green	■	■	■	■
Heliogen Viridine	■	■	■	■
Pigment Scarlet				
Permagen Scarlet		■	■	
Pyrazolone Reds		■	■	■
Vats				
Anthragen® Colors	■	■	■	■
Helio Fast Colors	■	■	■	■

*A partial listing of pigments from GDC. For further information contact your local GDC Technical Service Representative.

FROM RESEARCH TO REALITY

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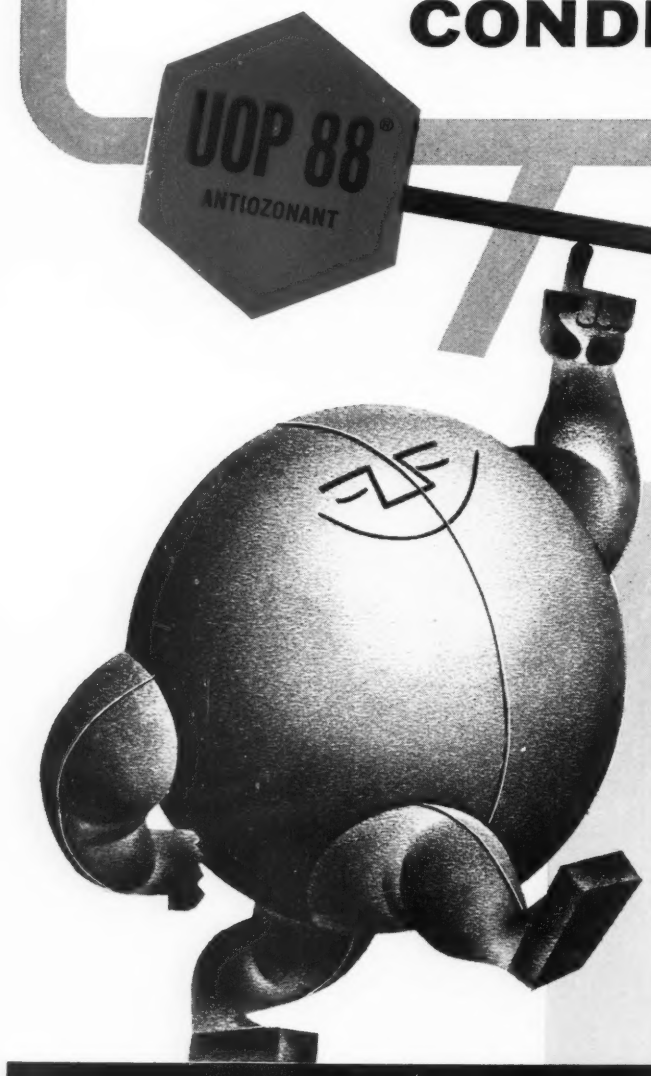
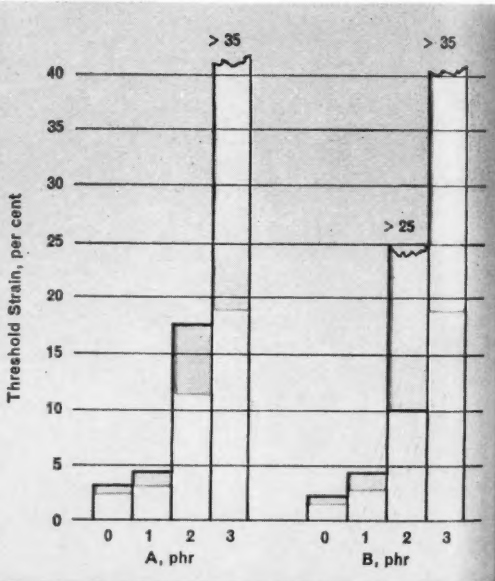
how can rubber be best protected against SEVERE OZONE CONDITIONS?





The two charts, above right, show results of tests made to determine antiozonant requirements of SBR stocks when subjected to stress at increasing ozone levels.

40 pphm ozone

120 pphm ozone

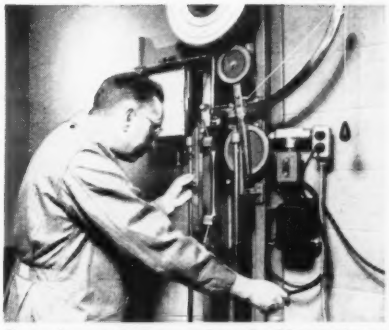
CHART A—Chart above shows effects of increasing antiozonant content of SBR stocks to meet increasing ozone level.

severe conditions of ozone and stress call for extra-special protection . . .

Smog which may contain up to 100 pphm ozone is hard on health and disposition. It is equally hard on rubber products. High ozone levels cause severe cracking in rubber formulations. In addition, stress also contributes to this problem as shown in Chart A, below left. How do you prevent such deterioration, assure long service life for your product under severest service conditions?

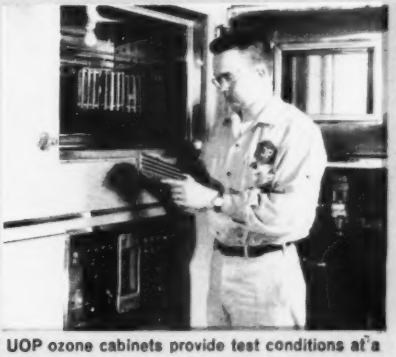
First, use antiozonants UOP 88 or 288, which offer maximum ozone protection. A relatively small loading of these low-cost antiozonants goes a long way in providing increased protection. Chart "B", for example, shows that 2 phr of antiozonant provides ample protection at an ozone concentration of 40 pphm, while an increase from 2 to 3 phr more than compensates for a 200% increase in ozone concentration.

Ozone concentration is but one of many factors to consider in manufacturing antiozonant-containing rubber products. Our staff of specialists, backed by UOP laboratory facilities and field experience, will be happy to discuss your problems with you. Simply write or telephone our Products Department.



Every day we test a number of rubber recipes. The Scott Tester is used to measure physical properties of an experimental vulcanizate.

To evaluate any service problem, test formulations are carefully compounded in this rubber mill by trained UOP technicians.



UOP ozone cabinets provide test conditions at a wide range of ozone concentrations.

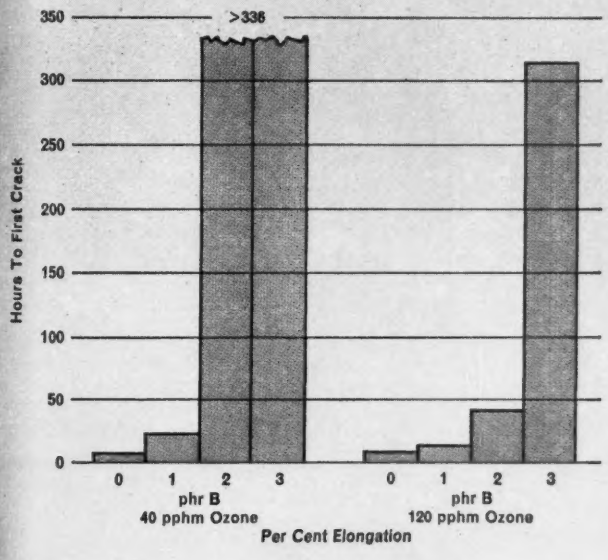


CHART B—Results of tests of two sets of samples containing varying amounts of antiozonants. Each were subjected to ozone concentrations of 40 pphm and 120 pphm. Note that an increase of 2 to 3 phr antiozonant proved adequate for the greatly increased ozone level.

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BOOK REVIEW

"Properties and Structure of Polymers." By Arthur V. Tobolsky. Cloth, 6 by 9¼ inches, 331 pages. John Wiley & Sons, Inc., New York 2, N. Y. 1960. Price $14.50.

This is one of a series on the Science and Technology of Materials and represents a valuable contribution in that area. The format is good, and the figures are large and clear, which make the book very readable. It would obviously be impossible to present a comprehensive treatise on the properties —and structure of polymers in a book of this size, and the research interests, of the author himself, as he states in the preface, have determined the selection of most of the material presented. Roughly one-half of the book is devoted to the pioneering work of the author and his associates and serves to locate the place of their contributions in the development of polymer science.

The book first treats thermodynamic and viscoelastic properties in a preliminary fashion and then delves into more specific aspects of polymer physics such as the disposition of the individual polymer chain molecule and the amorphous and crystalline states of aggregation, thermodynamic and kinetic factors involved, the five regions of viscoelastic behavior, the flow viscosity of linear amorphous polymers, and the kinetic theory of rubber elasticity. A very lucid account of the mathematical treatment of linear viscoelasticity, model theory, the Boltzmann principle, viscoelastic measurements and their analysis then precedes their application to the viscoelastic behavior of polymers. Here stress relaxation experiments are interpreted by means of the time-temperature superposition principle in terms of master curves; the characteristic parameters for amorphous polymers, such as the glass transition temperature, are discussed; more detailed attention is paid to the various regions of viscoelastic behavior, and allied topics such as molecular theory of viscoelasticity, heat generation in rubbers, stress relaxation in crystalline polymers, the creep of interchanging networks, and the significance of birefringence measurements are covered. The book is concluded by chapters on chemical stress relaxation and polymerization equilibria. Some of the mathematical derivations and recent work on the determination of maximum relaxation times are included as appendices.

The fact that this book is heavily weighted with the direct experiences of the author necessitates a certain loss of generality, but makes it that much

(Continued on page 50)

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Roebling Hose Wire, Hose Reinforcing Wire and Hose Wrapping Wire bear the stamp of Roebling's strict attention to constant uniformity. As with all Roebling wire products, each is wholly Roebling-made and Roebling-controlled, from open hearth to packaging. Tensile strength and forming qualities, finish and gage are of an excellence that proves itself in use.

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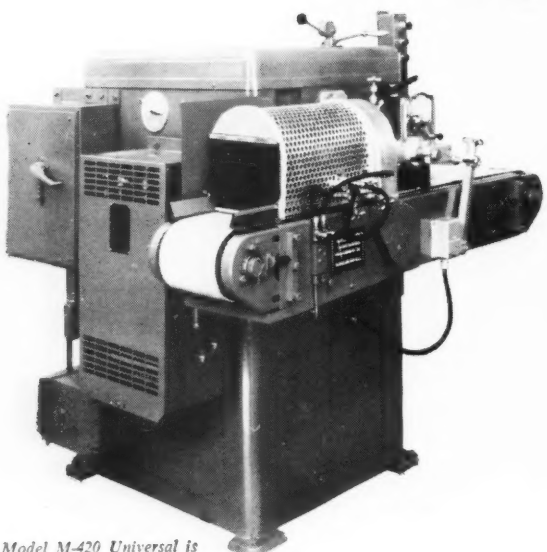
The Colorado Fuel and Iron Corporation

Typical rubber part molded from preps cut automatically by Wink Cutter at Monarch Rubber Co., Hartsville, Ohio.

"Wink Cutter saves us 50 manhours a day"...Monarch Rubber Company automates cutting of mold preps; eliminates double handling; speeds operations



Model M-420 Universal is a completely automatic machine for both continuous and intermittent cutting. Pays off on short or big runs. The built-in metering conveyor elements transport the uncut stock to the knives, precisely measure the length of cut and move the cut stock away from the blades. Wink actually measures while it cuts from four points simultaneously. It does not depend upon timing or synchronization with another unit or machine—does not cut against a dead element but against another live knife.

New—Large cutter handles up to 6-inch diameters. Write for information.

"The Wink Cutter has really paid off for us in cutting mold preps", reports Monarch Rubber Company, producers of a wide range of molded rubber products. "By automatically cutting mold preps right at the extruder, at rates up to 1500 pieces a minute, we're saving 50 manhours a day." In this operation, the extruded material was formerly cut into long strips, transported to a guillotine cutter, unloaded, and cut at much slower rates.

Accuracy of the Wink Cutter also saves money for Monarch. The Wink unit cuts each piece within a fraction of an ounce. By holding weight of each piece so closely, flashing in the mold is reduced, minimizing waste material. "It's the most accurate machine we've run across", reports Monarch, "and this is important in big production runs."

Wink Cutters *can help you* reduce costs in cutting rubber, both raw and cured, plastics, impregnated fabrics, reinforced hose, natural and synthetic fibers, ceramics, candy . . . even sticky or viscous materials. Write today for Bulletin W-100 . . . it lists complete engineering information. Contact Motch & Merryweather Machinery Company, Wink Cutter Division, 1250 East 222nd Street, Cleveland 17, Ohio.

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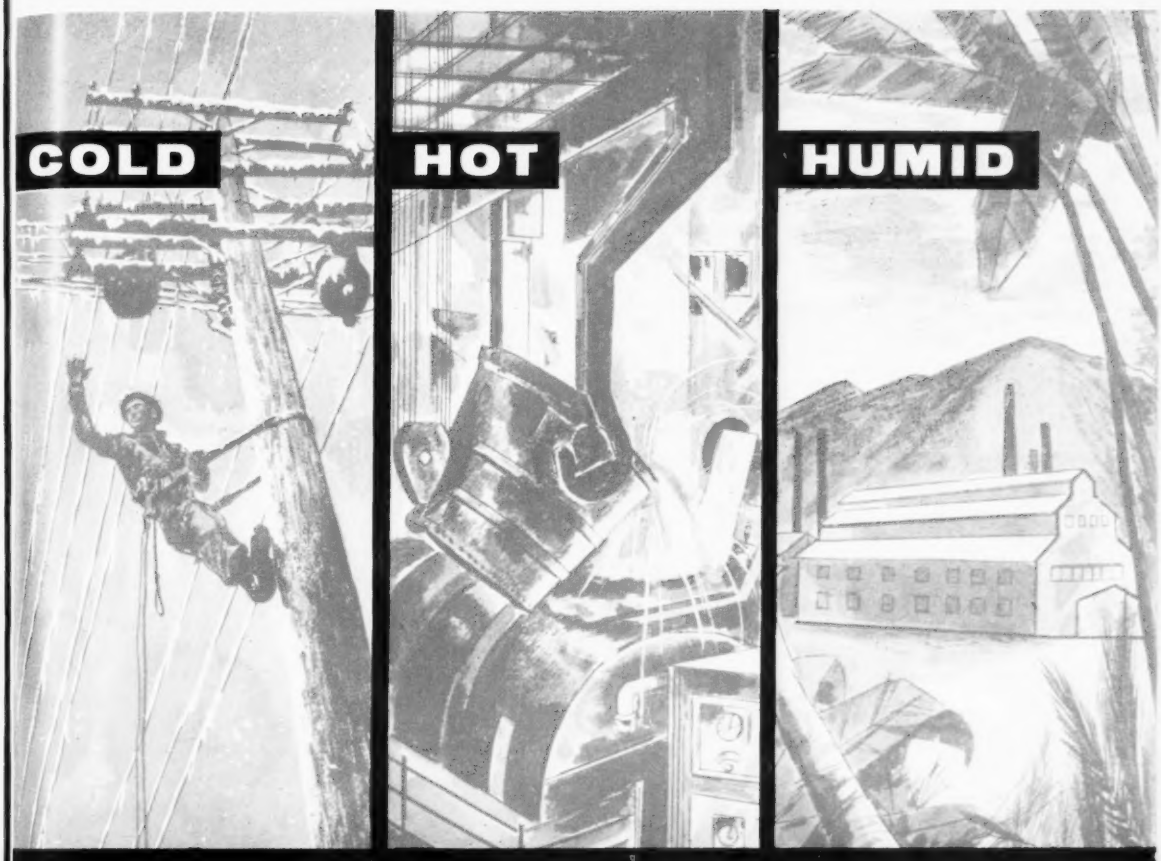

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technical books

(*Continued from page 46*)

more valuable in those areas in which he is expert. On the whole, this book should be a welcome addition to the libraries of workers in this and allied fields.

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NEW PUBLICATIONS

"Organic Solvents and Chemicals." Chemical Solvents Inc., Newark, N. J. 64 pages. This second edition of a handbook originally published in 1954 contains information on 150 chemical products, with tables for temperature conversion and for gaging contents of 55-gallon drums.

"Resistance of Polysulfide Rubber to Halogenated Hydrocarbons." Bulletin PS-1. Thiokol Chemical Corp., Trenton, N. J. 8 pages. This bulletin compares resistance of three types of polysulfide rubbers, FA, ST, and ZR-300, in representative aliphatic and aromatic halohydrocarbons and also compares resistance of Polysulfide FA with those of nitrile, Neoprene GN, SBR, butyl, and natural rubber.

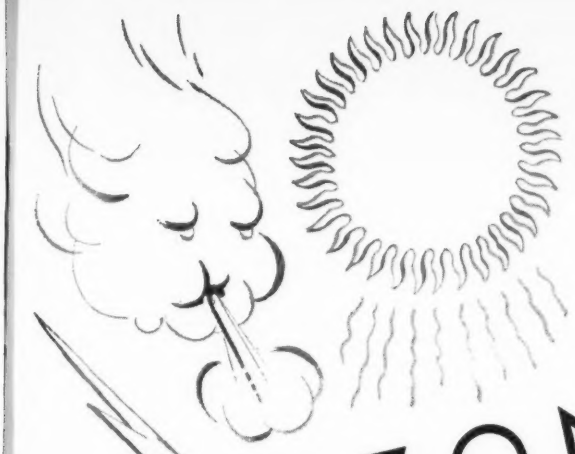
"Ethers, Solvents, Extractants, Inert Reaction Media." Union Carbide Chemicals Co., New York, N. Y. 40 pages. This booklet describes in some detail properties and uses of ethyl ether, isopropyl ether, butyl ether, 1,4-dioxane, and the glycol diethers, diethyl Carbitol, dibutyl Carbitol, and methyl ethyl Carbitol. Included is information on physical properties, solubilities, constant-boiling mixtures, specification limits, test methods, physiological properties, and storage, handling, and shipping.

Publications of Goodrich-Gulf Chemicals, Inc., Cleveland, O.:

"Micro-Black Masterbatch." Technical Data Bulletin No. 132. 1 page. This bulletin lists chemical and physical properties of Ameripol 4667, an oil black masterbatch with a staining antioxidant. Suggested applications include tires, tread rubber, and belting.

"Ameripol 1502." Technical Data Bulletin No. 133. 1 page. This bulletin lists properties of Ameripol 1502, a light-colored, non-staining, and non-discoloring SBR rubber, suggested for white sidewall tires, sporting goods, floor coverings, and shoe soles and heels.

"Ameripol 4700." Technical Data Bulletin No. 131. 1 page. This bulletin suggests applications and lists physical properties of Ameripol 4700, an oil-extended non-staining, light-colored rubber, used for tile, soles and heels, molded goods, extrusions, sponge, sporting goods, toys, and household items.



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technical books

"Synpol for Wire and Cable Applications." Bulletin No. 4. Texas-U.S. Chemical Co., New York, N. Y. 11 pages. This bulletin lists current types of Synpol SBR polymers recommended for use in wire and cable insulations, giving suggested polymers and compounding for various applications, with tabulated physical properties for each suggested compound.

"Carbon Blacks in High Durometer Neoprene Compounds." Rubber Chemicals Bulletin No. 34. Phillips Chemical Co., Akron, O. 18 pages. This publication compares effects of loadings of Philblack A, O, I, and E furnace blacks in Neoprene W with those of EPC, SRF, and MT blacks at loadings corresponding to 72 and 85 Shore A durometer hardness.

"Engineering Index." Engineering Index, Inc., 29 W. 39th St., New York, N. Y. This publication contains 34,000 abstracts of engineering articles in 1,800 engineering and technical periodicals in the United States and 44 foreign countries, plus reports of government and research organizations and scientific, engineering, and technical societies. Abstracts are divided into 249 divisions of engineering. Included are a 12-page list of publications used and also an author index. A daily or weekly card index service is available to subscribers.

"Teflon Coating." Cadillac Plastic & Chemical Co., Detroit, Mich. 4 pages. This folder describes applications for Teflon coating of metal and ceramic tools and parts to contribute anti-sticking or chemically resistant properties. Among anti-sticking applications is mixing, handling and storing equipment for rubbers, plus extrusion dies, forming and curing molds, mandrels, calender end plates, laminating platens, and boot lasts.

"Receiver Gauges." Catalog 520. United States Gauge, Sellersville, Pa. 8 pages. The catalog describes the special-purpose low-pressure gages used to indicate values transmitted by pneumatic signal from a remote location.

Publications of Goodyear Tire & Rubber Co., chemical division, Akron, O.:

"Plioflex 1500C Pigmentation Study." Bulletin PF-38. 11 pages. This bulletin gives results of tests in compounding Plioflex 1500C, a cold SBR, with seven blacks and five non-black pigments.

"Plioflex 1712C Pigmentation Study." Bulletin PF-39. 11 pages. Similar to Bulletin PF-38, this gives results of compounding Plioflex 1712C, a cold, oil-extended SBR, with the same seven blacks and five non-blacks as with 1500C.

"Improved Processability in Plioflex 1778." Bulletin PF-40. 3 pages. This bulletin compares properties and processing power consumption of an improved Plioflex 1778 SBR with the standard 1778.

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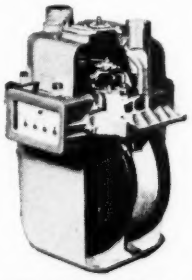

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Publications of Dow Corning Corp., Midland, Mich:

"Silastic 1601." Bulletin 9-395. 2 pages. This bulletin lists physical and electrical properties of this wire insulation stock.

"Silastic 1602." Bulletin 9-396. 2 pages. This data sheet covers physical and electrical properties of Silastic 1602, an insulation stock.

"Blending Silastic and Silastic LS Stocks." Bulletin U-9-115. 2 pages. Presented are suggestions for blending general-purpose Silastic with Silastic LS, a fluorosilicone, for an economical end-product with a moderate solvent resistance. A chart which equates price and swell is included.

"Shrinkage of Silicone Rubber during Fabrication." Bulletin U-9-113. 2 pages. This bulletin discusses the causes of shrinkage and offers suggestions for cutting shrinkage.

"Recommended Quantities of Vulcanizing Agents for Various Silastic Materials." Bulletin 9-227a, replacing Bulletin 927. 1 page.

"Vulcanizing Silicone Rubber." Bulletin U-9-116. 2 pages. This bulletin covers vulcanizing and vulcanizing agents, together with two of the most common factors for loss of vulcanizing efficiency. Also listed are preferred vulcanizing agents for various uses.

"Weather Resistance of Silastic." Bulletin U-9-111. 2 pages. This bulletin gives results of tests conducted by exposing continuously samples of Silastic to the weather at locations in Midland, Mich., and southern Florida for periods of one year to 10 years.

"Silicones Solve Space Age Problems." Dow Corning Corp., Midland, Mich. 8 pages.

"C-P-B, Z-B-X, D-B-A, Low-Temperature Accelerators for Natural, Reclaim, SBR, Paracril, and Neoprene Rubbers." Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn. 4 pages.

"Specimen Dimension Compensator for Reading Unit Stress." Scott Testers, Inc., Providence, R. I. 1 page.

"Hooker Chemicals." Bulletin 100-D. Hooker Chemical Corp., Niagara Falls, N. Y., 16 pages.

"The Breon Rubber Story." British Geon, Ltd., Devonshire House, Piccadilly, London W.1, England. 20 pages.

"Adamson-Shaw Intermix." Adamson United Co., Akron, O. 4 pages.

"G-E Mobile Radio Bulletin." ECR-497B. **"G-E Closed Circuit TV Bulletin."** ECL 85. General Electric Co., communication products department, Lynchburg, Va.

"Splicing of Tread Rubber." Bulletin No. 11. Retread and Repair Materials Committee, The Rubber Manufacturers Association, Inc., New York, N. Y. 2 pages.

"Aliphatic Organic Chemicals." Armour Industrial Chemical Co., Chicago, Ill. 8 pages.

"Air Line Conveying Systems." Bulletin M-260. Day Co., Minneapolis, Minn. 16 pages.

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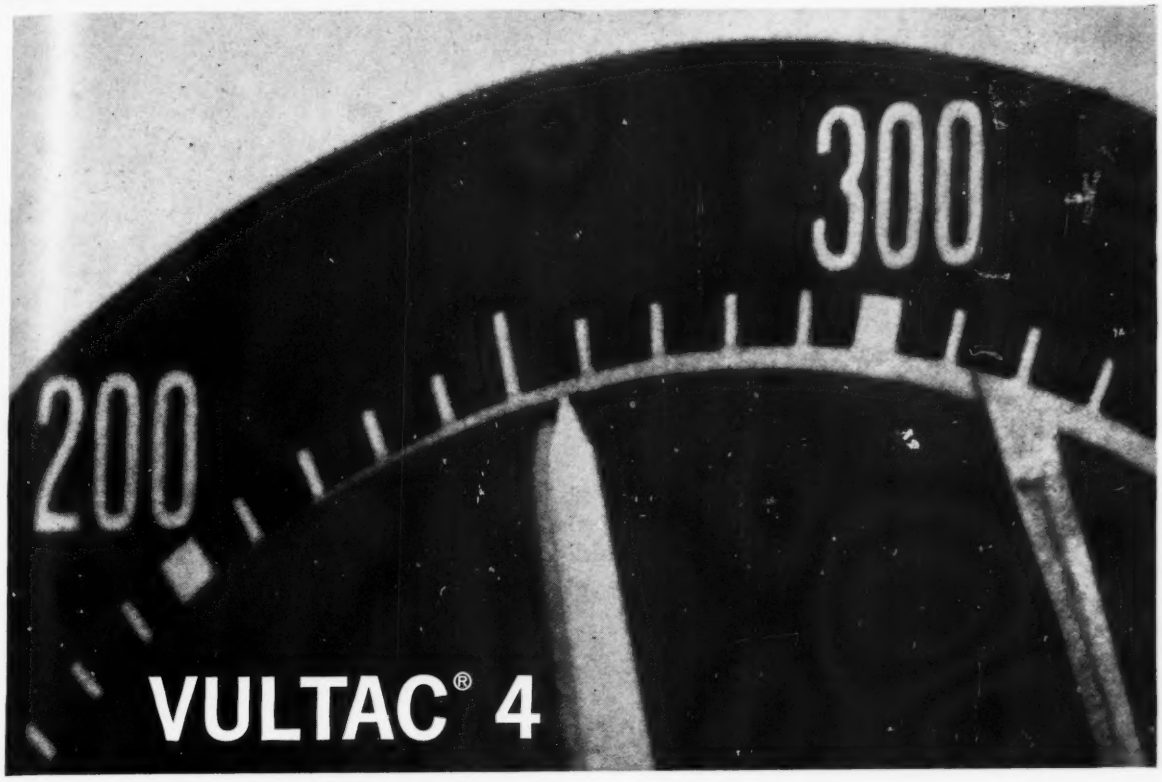

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Softening range	50-60°C	78-93°C	48-53°C
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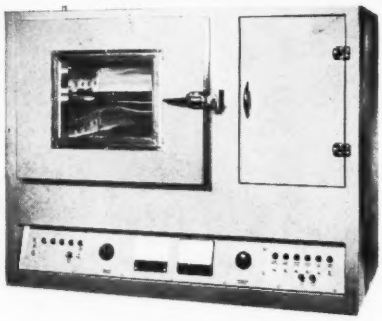

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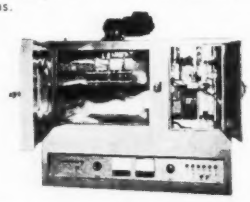

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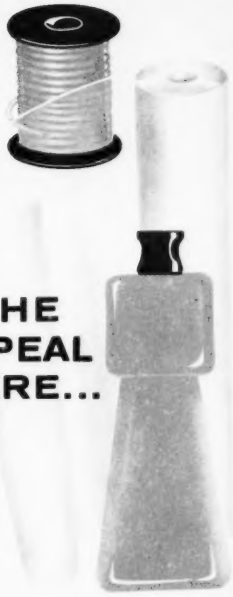

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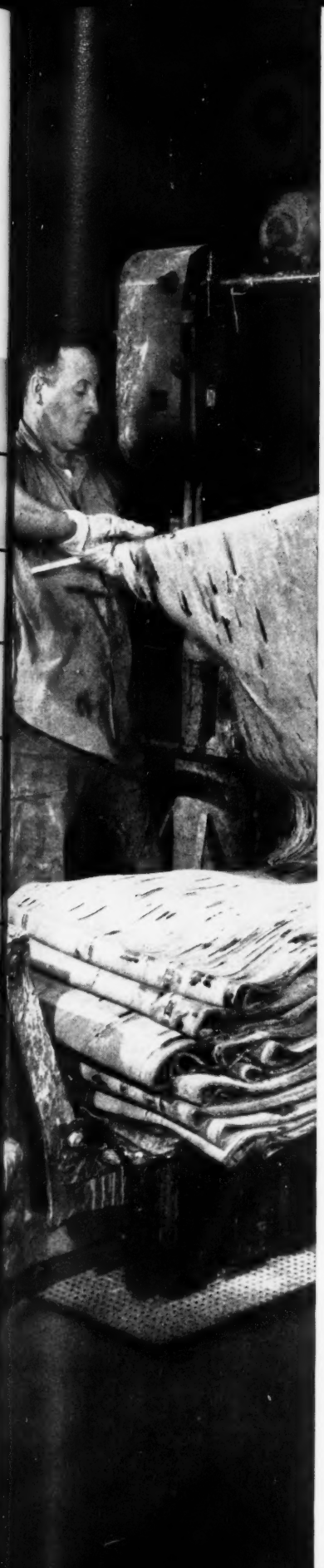

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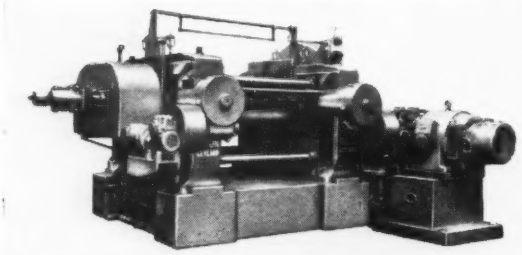

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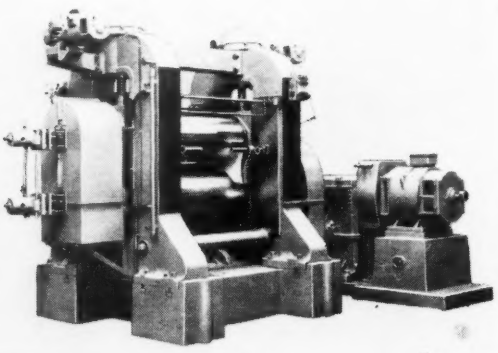

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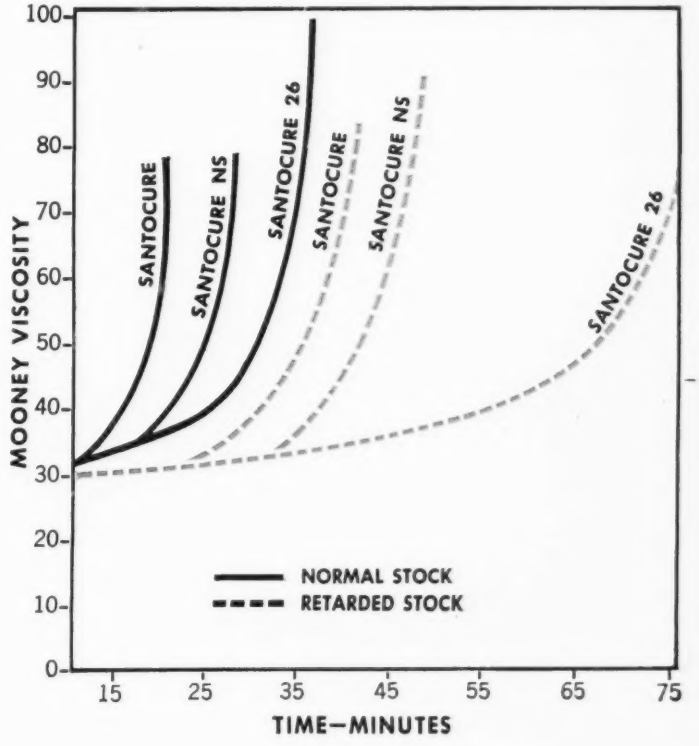

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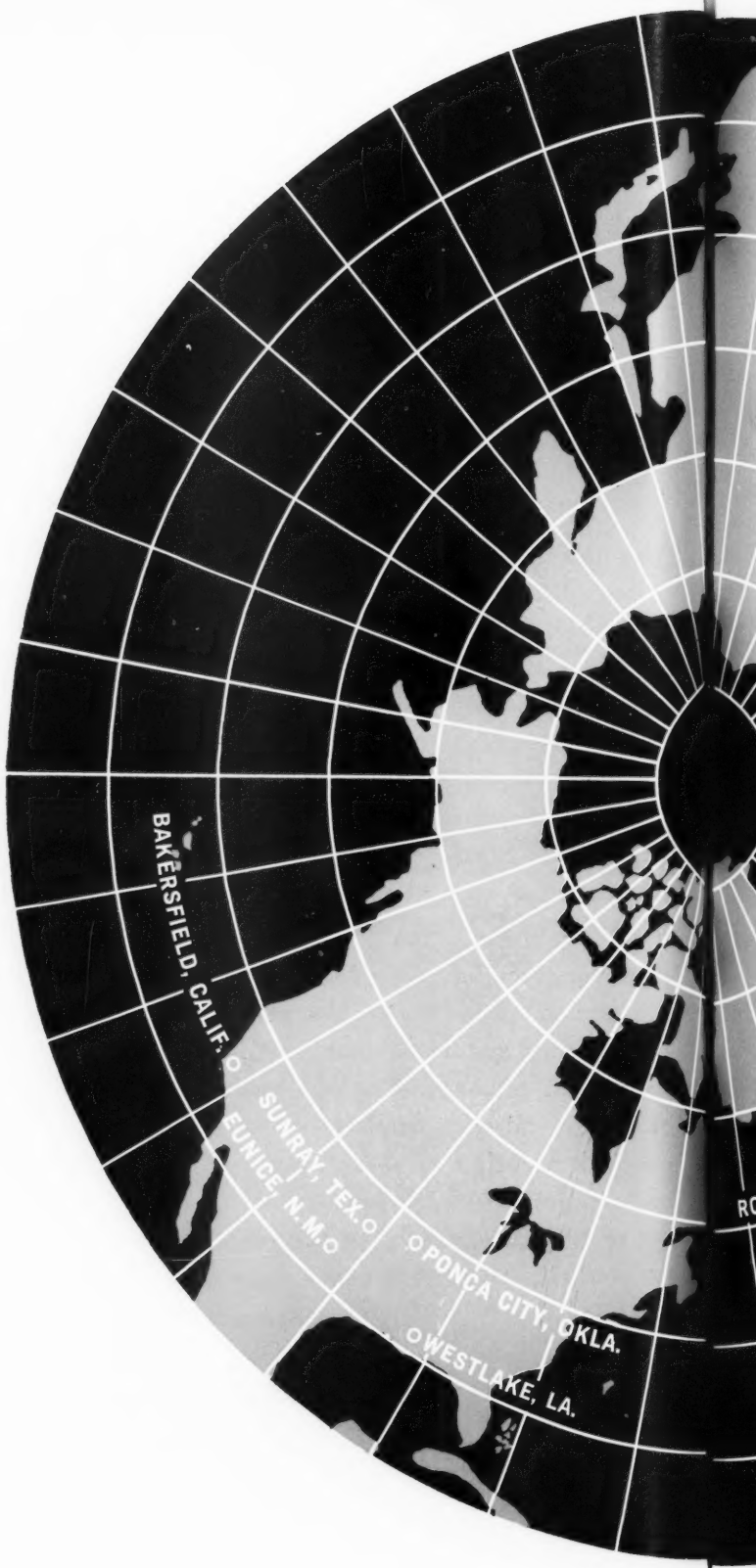
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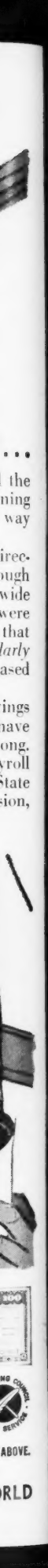

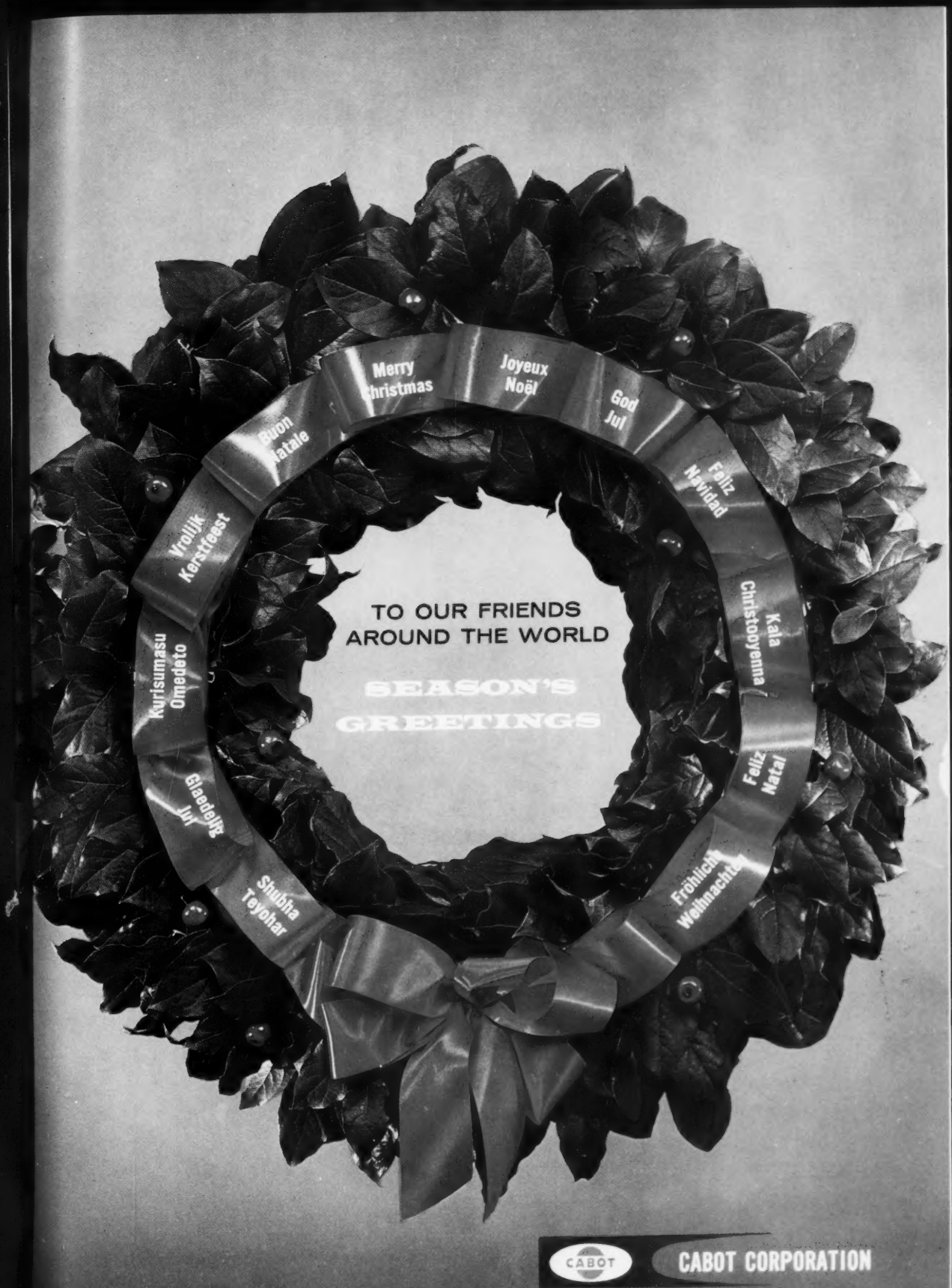

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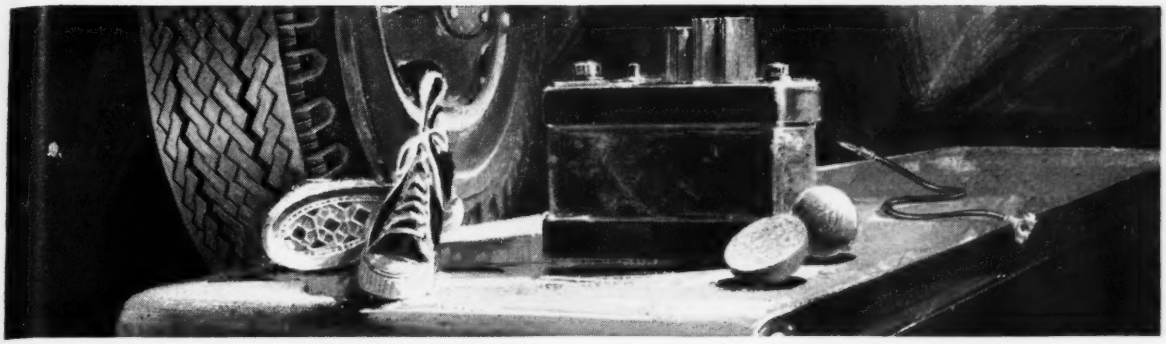

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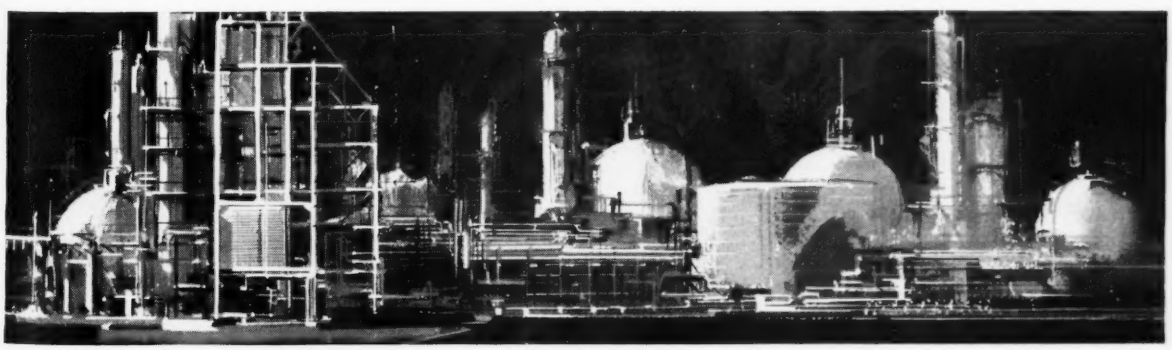

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editorial

Rubber Supply and Price Outlook Is Very Good for the 1960's

As the year 1960 draws to a close, it appears that the world will have more rubber of a greater variety of types and at a lower average cost during the present decade than at any time since World War II. Under these conditions an increase in the per capita consumption greater than some of the more conservative estimates and many new and better rubber products may be expected.

The essence of recent statements by industry leaders on the Free World rubber producing capacity and demand situation seems to be that there are about 400,000 long tons more capacity for synthetic rubber this year (mostly in the United States), than will be used. By 1965 there will be about 800,000 tons excess synthetic capacity if the rubber consumption growth rate remains at the estimated 4.5% a year in Western Europe and at 3% a year in the United States.

Natural rubber production plus stockpile releases this year will provide about 150,000 tons more than estimated consumption requirements. In 1965, natural rubber production could increase from the present 2.0 million tons a year to between 2.2 and 2.3 million tons, and there may still be releases of natural rubber from government stockpiles at that time. Free World demand for natural rubber in 1965 may remain at the present 1.6 million tons because of the planned production of 500,000 tons of the stereo rubbers, polyisoprene and polybutadiene. These rubbers replace natural rubber either wholly or in part to a greater extent than SBR.

The Soviet bloc countries' present use of about 400,000 tons of natural rubber a year may increase to 500,000 tons in 1965, according to one authority. Soviet bloc countries have plans for a large increase in their synthetic rubber capacity, however, and may reduce their natural rubber consumption to the extent they achieve this increase.

There is a good possibility, therefore, that these various developments will stabilize the price of natural rubber in the 1960's at a level equal to or below the present price of SBR. Spokesmen for the natural rubber producing industry in Malaya have indicated that continuing yield improvements may permit them to land rubber in New York at a cost between 17½¢ and 22½¢ a pound, if necessary.

Meanwhile, R. D. Dinsmore, Goodyear's research vice president, indicated in a talk before the Rubber Manufacturers Association in New York in November that the stereo rubbers, polyisoprene and polybutadiene, would have to compete in a 20¢-25¢ a pound market in the future. This price is not possible with the present state of our knowledge for producing these rubbers, but could be if cheaper starting materials and more economic methods for conversion to rubber are developed as the result of continuing research.

In another development, natural rubber producers have indicated that they will emphasize the use of their rubber for blending with stereo rubbers, particularly polybutadiene, which at the present time seems to require use in blends for best results. Synthetic polyisoprene may be used directly as a 100% replacement for natural rubber.

The outlook for the 1960's is for a lot of rubber at reasonable prices, a situation which should provide a good climate for the production of more and better rubber products the world over.

R. G. Seaman

EDITOR

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Radiation-Induced Compression Set On Elastomeric Compounds[1]

The need of more radiation-resistant elastomers and more effective antirads is shown

By E. E. MOONEY and S. T. SEMEGEN

B. F. Goodrich Co. Research Center, Brecksville, O.

S. T. Semegen

E. E. Mooney

RECENTLY we have been conducting a survey of the radiation resistance of conventional and specialty elastomers[2-5] to gamma radiation. This survey has two main objectives: (1) the establishment of "control" performance of elastomeric compounds and end-items in a radiation field mixed with other environments and (2) the development of means of protecting such compounds against the damaging effects of ionizing radiation.

Elastomeric vulcanizates find wide application in aircraft and other vehicles under conditions of compressive stress in gaskets, seals, hose, mountings, etc. The effects of radiation are, then, being studied on the basis of compression as well as other physical properties. Ideally, a measurement of stress decay during compression as a function of radiation exposure dose would be made. Instead, a secondary measurement has been employed which uses compression set in a modification of ASTM[6] D 395-55, Method B, the constant deflection measurement.

Radiation-compression set studies have been made at room temperature in air and in some cases in C_{14}—C_{16} alkyl diphenyl ether, a hydraulic fluid recommended by Wright Air Development Center for radiation stability. Other environments such as heat combined with radiation are presently being investigated.

Experimental Details

The following aircraft-type compounds representing four important applications have been tested in the radiation-compression set program: (1) Neoprene (CR) wire insulation. (2) Ameripol[7] (SBR) wire insulation. (3) Neoprene (CR) packing compound. (4) Hycar[8] (NBR) packing compound. (5) Hycar (NBR)-Vinylite[9] fuel cell bladder stock. (6) Hycar (NBR) fuel cell liner stock. (7) Hycar (NBR)-Ameripol (SBR) hose tube stock. (8) Neoprene (CR) hose tube stock.

Nine elastomers were tested as ASTM D 15-57T or supplier test compounds in the radiation-compression set program as follows: (1) Ameripol (SBR) compound (ASTM D 15-57T, No. 2B). (2) Hycar (NBR) compound. (3) Natural rubber (NR) compound (ASTM D 15-57T, No. 3A). (4) Neoprene (CR)

---

[1] Presented before the Division of Rubber Chemistry, ACS, Buffalo, N. Y., May 4, 1960. The work was performed under U. S. Air Force contract; the sponsoring agency was the Materials Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio.

[2] J. W. Born *et al.*, "A Study of the Effects of Nuclear Radiations on Elastomeric Compounds and Compounding Materials," WADC Technical Report 55-58, Parts IV, VI, B. F. Goodrich Research Center (1958-60).

[3] D. J. Harmon *et al.*, *Ibid.*, Part V, (1959).

[4] J. W. Born, E. E. Mooney, S. T. Semegen, RUBBER WORLD, 139, 379 (1958).

[5] E. E. Mooney and S. T. Semegen, "Radiation and Other Environment Effects on Elastomeric Compounds," Fourth Radiation Effects Symposium, Sept. 16, 1959, Cincinnati, O.

[6] American Society for Testing Materials, Philadelphia 3, Pa.

[7] Goodrich-Gulf Chemicals, Inc., Cleveland 14, O.

[8] B. F. Goodrich Chemical Co., Cleveland 15, O.

[9] Union Carbide Plastics Co. Division, Union Carbide Corp., New York 17, N. Y.

TABLE 1. RECIPES FOR AIRCRAFT COMPOUNDS

Neoprene (CR) Wire Insulation	
Neoprene Type GN	100
MPC Black	10
PBNA	2
Mineral rubber	10
Clay	35
Talc	35
Whiting	35
Paraffin wax	6
Petrolatum	3
Light magnesium oxide	4
Zinc oxide	10
	250

Cure: 35 min. @ 293° F.

Ameripol (SBR) Wire Insulation	
Ameripol 1007	100
EPC Black	20
Whiting	78.5
Clay	120
Mineral Rubber	60
Zinc oxide	4
PBNA	2
Stearic acid	1
Paraffin wax	6
Altax*	3
TMTD	1.5
Litharge	1.5
Sulfur	2.5
	400.0

Cure: 20 min. @ 293° F.

Neoprene (CR) Packing Compound	
Neoprene Type W	60
WHV	40
MT Black	35
Fatty acid ester	20
PBNA	2
Sun-resistant wax	1
MBTS	1
2-Mercaptoimidazoline	1
Light magnesium oxide	2
Zinc oxide	5
	167

Cure: 30 min. @ 293° F.

Hycar (NBR) Packing Compound	
Hycar 1001	80
1002	20
EPC Black	40
Zinc oxide	5
Fatty acid ester	10
Dioctyl phthalate	10
Tributoxy ethyl phosphate	15
Lauric acid	0.75
TMTD	0.10
MBTS	1.25
Sulfur	1.25
	183.35

Cure: 30 min. @ 293° F.

Hycar (NBR)-Vinylite Fuel Cell Bladder Stock	
Hycar 1043	100
Vinylite VYNV-2	20
Hycar 1312	12
SRF Black	80
Basic lead carbonate	0.6
Zinc oxide	5.0
Stearic acid	1.0
Dibutyl Sebacate	20.0
Vultrol*	0.5
TMTM	0.3
MBTS	1
Sulfur	1
	241.4

Cure: 35 min. @ 293° F.

Hycar (NBR) Fuel Cell Liner Stock	
Hycar 1011	100
SRF Black	80
Zinc oxide	5
Dibutyl phthalate	30
Stearic acid	1
TMTM	0.3
MBTS	1
Sulfur	1
	218.3

Cure: 30 min. @ 293° F.

Hycar (NBR)-Ameripol (SBR) Hose Tube Stock	
Hycar 1043	85
Ameripol 1001	15
SRF Black	130
Zinc oxide	5
AgeRite Powder†	2
Fatty acid ester	15
Tributoxy ethyl phosphate	10
MBTS	2
Sulfur	2
	266

Cure: 35 min. @ 293° F.

Neoprene (CR) Hose Tube Stock	
Neoprene Type GN	100
MT Black	60
SRF Black	30
AgeRite Resin D†	1.5
Lauric acid	2
Light processing oil	5
MBTS	2
Light magnesium oxide	4
Zinc oxide	5
	209.5

Cure: 25 min. @ 293° F.

TABLE 2. RECIPES FOR ASTM OR SUPPLIER TEST COMPOUNDS

Ameripol (SBR) Compound (ASTM Method D 15-57T, No. 28)	
Ameripol 1500/1501	100
EPC Black	40
Zinc oxide	5
Stearic acid	1.5
Altax	3
Sulfur	2
	151.5

Cure: 140 min. @ 293° F.

Hycar (NBR) Compound	
Hycar 1001	100
SRF Black	50
Zinc oxide	5
Altax	3
Sulfur	2
	160

Cure: 100 min. @ 293° F

Natural Rubber (NR) Compound (ASTM D 15-57T, No. 3A)	
Natural Rubber	100
AgeRite Powder	1
EPC Black	50
Zinc oxide	5
Stearic acid	3
Altax	1
Sulfur	3
	163

Cure: 50 min. @ 293° F

Neoprene (CR) Compound (ASTM D 15-57T, No. 2C)	
Neoprene Type GN	100
EPC Black	35
Stearic acid	1
Light magnesium oxide	4
Zinc oxide	5
	145

Cure: 105 min. @ 293° F.

"Hypalon" 20 Compound	
"Hypalon" 20	100
HAF Black	20
Rosin	2.5
Tetrone A‡	1
Light magnesium oxide	30
	153.5

Cure: 80 min. @ 293° F.

Hycar 4021 Compound	
Hycar 4021	100
FEF Black	40
Stearic acid	1
Trimene Base§	3
Sulfur	0.5
	144.5

Cure: 20 min. @ 293° F. (press)
24 hrs. @ 293° F. (oven)

"Viton" A Compound	
"Viton" A	100
MT Black	25
AgeRite White	0.2
Heavy magnesium oxide	20
Diak No. 1‡	1.3
	146.5

Cure: 30 min. @ 320° F. (press)
24 hrs. @ 400° F. (oven)

Thiokol ST	
Thiokol ST	100
SRF Black	50
Stearic acid	1
GMF-117§	3
Zinc chromate	10
	164

Cure: 15 min. @ 293° F. (press)
24 hrs. @ 212° F. (oven)

Thiokol FA Compound	
Thiokol FA	100
SRF Black	40
Stearic acid	0.5
MBTS	0.3
DPG	0.1
Zinc oxide	10.0
	150.9

Cure: 45 min. @ 293° F.

* B. F. Goodrich Chemical Co.
† R. T. Vanderbilt Co., New York 17, N. Y.
‡ Du Pont elastomer chemicals department.
§ Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.

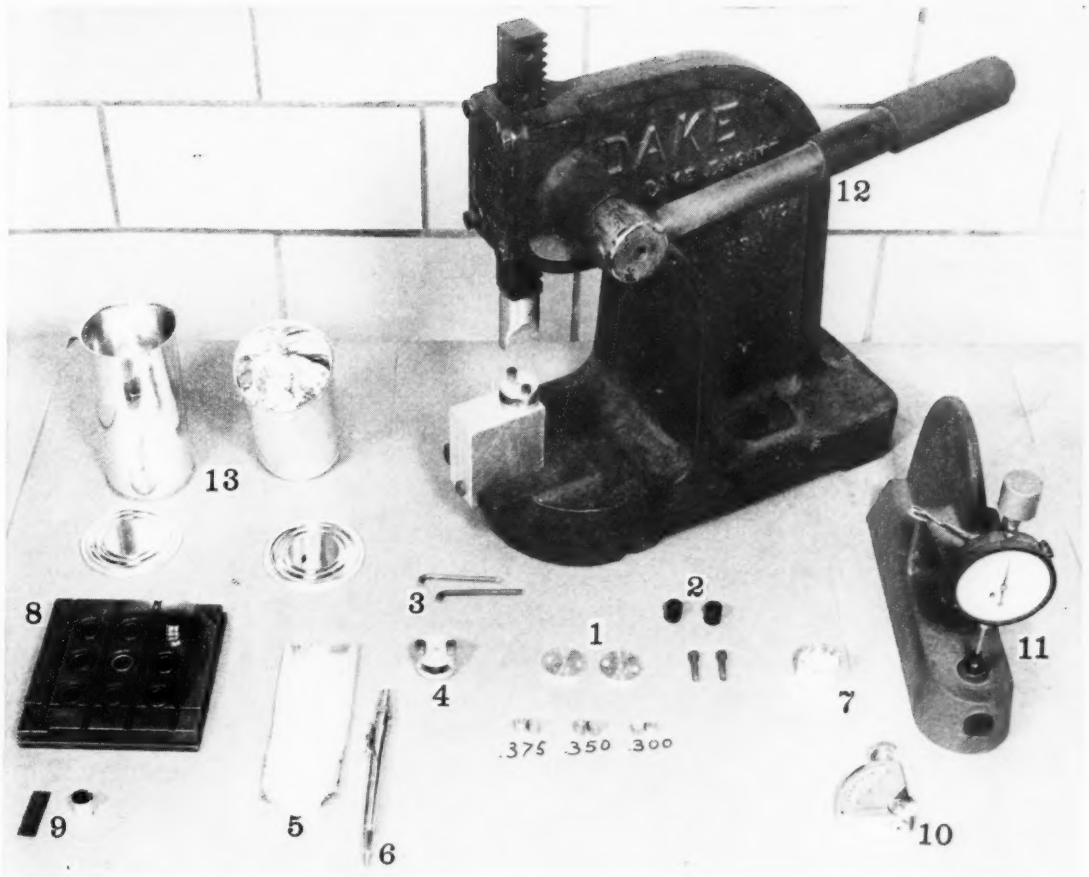

Fig. 1. Equipment used for radiation-compression set work. The numbers identify the equipment as follows: (1) Disassembled aluminum compression jig including circular plates, screws, tubular spacers of various heights, etc. (2) Elastomer pellets, 1/2-inch diameter, 1/2-inch thick. (3) Allen wrenches. (4) Assembled aluminum compression jig. (5) Aluminum foil (for wrapping jigs). (6) Tech. pen for labeling wrapped jigs. (7) Wrapped, identified, assembled aluminum compression jig. (8) Elastomer pellet mold (for compounds not easily molded in block form). (9) "Teflon"-coated aluminum pellet mold liner. (10) Shore A durometer for hardness. (11) ASTM pellet thickness gage. (12) Hand arbor press (for closing jigs evenly). (13) Materials Testing Reactor (MTR) tin can (fully loaded). The small size of the equipment is very apparent.

compound (ASTM D 15-57T, No. 2C). (5) "Hypalon"[10] 20 compound. (6) Hycar 4021[11] compound. (7) "Viton" A[12] compound. (8) Thiokols[13] ST and FA compounds. (NBR is the ASTM D 1418-58T designation for nitrile-butadiene rubber; CR, for chloroprene rubber; SBR, for styrene-butadiene rubber, and NR for natural rubber.)

These latter elastomers are in comparative recipes and hence lend themselves to side-by-side comparisons. The detailed recipes for all compounds are given in Tables 1 and 2.[2-3]

All compounds were evaluated for radiation-compression set with and without potential antirads, i.e., radiation damage inhibitors, at a concentration of 5 phr. Some of the potential antirads that were used in these two groups of compounds are as follows: (1) 35% diphenyl-p-phenylene diamine + 65% phenyl-α-naphthylamine (Akroflex C[14]). (2) Quinhydrone. (3) Hydroquinone. (4) N-cylohexyl-N′-phenyl-p-phenylene diamine (Antiox 4010[15]). (5) N, N′-dioctyl-p-phenylene diamine (UOP 88[16]). (6) α-naphthylamine. (7) N-phenyl-N′-o-tolylethylene diamine (FLX[17]).

The equipment used for the compression set studies is shown in Figure 1. Compression of rubber pellets depends on compound hardness.

Pre-Irradiation Set

The major modification in the ASTM D 395-55, Method B, compression set test comes not only in the use of an elastomer pellet of non-standard size, but

[10] E. I. du Pont de Nemours & Co., Inc., elastomer chemicals department, Wilmington 98, Del. Chlorosulfonated polyethylene.
[11] B. F. Goodrich Chemical Co. Polyacrylic rubber.
[12] DuPont Elastomer Chemicals Dept. Copolymer of vinylidene fluoride and hexafluoropropylene.
[13] Thiokol Chemical Corp., Trenton 7, N. J. Polysulfide rubbers.
[14] Du Pont elastomer chemicals department.
[15] Farbenfabriken Bayer AG, Leverkusen, Germany.
[16] Universal Oil Products Co., Des Plaines, Ill.
[17] C. P. Hall Co., Akron, O.

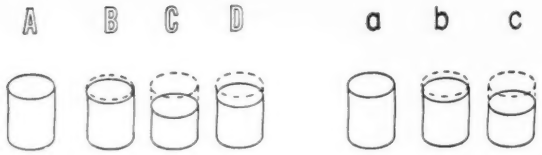

Fig. 2. Radiation-compression set pellet (MTR exposure), *left*. A is initial thickness; B is thickness after pre-irradiation set and just prior to irradiation at MTR; C is spacer thickness; D is thickness after irradiation. Control (unirradiated) compression set pellet, *right*. a is initial thickness; b is thickness after room temperature set; c is spacer thickness

also in the calculation of the % compression set. This method requires that there be no pre-exposure set. Under the present circumstances of operation, rubber specimens are compressed at the B. F. Goodrich Co. Research Center, Brecksville, O., and irradiated at the Materials Testing Reactor (MTR), Idaho. The period of time between compression and irradiation results in pre-irradiation set. This pre-set is generally different for all compounds, depending on polymer, state of cure, type of compounding, etc. It can generally be ascribed to viscoelastic relaxation, oxidative effects, etc. The calculation found to be most satisfactory for determining radiation-compression set, thus far, is the following (see also Figure 2), which corrects for pre-irradiation set:

$$\% \text{ Radiation-compression set} = \left(\frac{B-D}{B-C}\right) \times 100$$

$$\% \text{ Control-compression set} = \left(\frac{a-b}{a-c}\right) \times 100$$

Let x = Control-compression set after pre-irradiation compression time (t)

$$= \left(\frac{a-b}{a-c}\right)_t = \left(\frac{A-B}{A-C}\right)_t$$

Then pre-irradiation set, $B = A - x(A-C)_t$

Given on the left in Figure 2 are four views of an elastomer pellet for radiation—on the right, three views of a control (un-irradiated) pellet. The radiation pellet has initial thickness A. It is compressed to thickness C at Brecksville, O., and shipped to MTR, Idaho. After irradiation it returns to Brecksville; the jig is opened, and the recovered thickness D is measured. The compression set results reported in this paper are based on measurements of pellet thickness made 30 minutes after release from the jig; however, measurements of equilibrium recovered thickness have also been made. Thicknesses A, C, and D are measured directly at Brecksville.

While the radiation pellet travels from Brecksville to Idaho, the compression time prior to irradiation is anywhere from 15 to 140 days, depending on experimental purpose, shipment and loading time, etc. Hence, initial thickness A, when compressed to thickness C, effectively relaxes to some lower thickness B before irradiation. Commensurate with ASTM D 395-55, Method B, the thickness just prior to exposure is used in the calculation of radiation-compression set, i.e.,

$$\frac{B-D}{B-C} \times 100$$

Now, experimentally, thickness B can only be determined indirectly. This measurement is made using a separate group of control pellets whose various, corresponding thicknesses are given by a, b, and c, all of which are measured directly at Brecksville. A plot of control compression set $a-b/a-b \times 100$ *versus* compression time (up to 140 days) is made. Knowing the date of the irradiation of the radiation pellet, the total compression time (t) prior to irradiation is figured. Knowing time (t) the corresponding control-compression set (x) is scaled from the control-compression set curve. Since (x) is the same for both radiation and control pellets, we can equate (x) not only to $(a-b/a-c)_t$, but also to $(A-B/A-C)_t$. Hence the pre-irradiation set B is calculated as $B = A-x(A-C)_t$.

Typical Radiation-Compression Set Curves

Figure 3 shows a typical compression set plot, in this case for a natural rubber compound in air at room temperature. All compounds tested for compression set have been plotted in this way, showing control-compression set as the lower curve, radiation-compression set as the upper curve, the lower abscissa as control-compression time (in days), and the upper abscissa as radiation dose in both reps.[18] and ergs per gram of carbon[19] [ergs/gram (C)]. Note that the conversion from reps. (air) to ergs/gram(C) is made by multiplying by 87.1. The value (x) is the pre-irradiation control-compression set. The broken arrows on the radiation-compression set curve indicate radiation-compression set at 5.23×10^9 ergs/gram (C) (or 6×10^7 reps.) and the dose required for 50% set which are two arbitrarily selected points along the radiation-compression set

[18] One roentgen-equivalent-physical or rep. was a term in common use before "ergs per gram of carbon" was recommended and is equivalent to 84.6 ergs of absorbed radiation energy (produced by Compton scattering) per gram of carbon.

[19] The erg per gram of carbon has been recommended by the ANP Advisory Committee for Nuclear Measurements and Standards for all Air Force programs of radiation research and development. It is the unit of "carbon dose" which is defined as the energy removed from an X- or gamma radiation field per unit mass (hence erg per gram) by a limiting small piece of carbon. "Carbon dose," as measured by a carbon equivalent ionization chamber, has been chosen as the common denominator of gamma dosimetry.

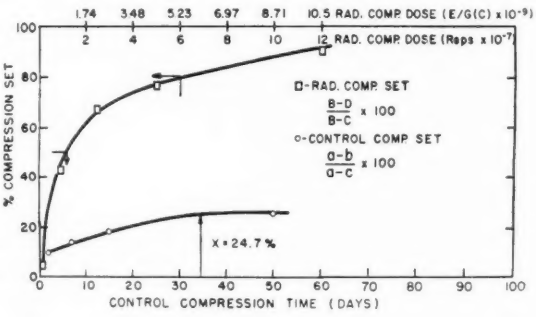

Fig. 3. Radiation-compression set for a natural rubber (NR) compound in air at room temperature

curve which serve as convenient locations for comparison of radiation resistance.[20]

Radiation-compression set studies of pellets immersed in alkyl diphenyl ether have also been made. The experimental procedure for this study was the same as for compression set measurement at room temperature in air except that alkyl diphenyl ether replaced air. Here, the compression jigs are contained in one-ounce jars filled with the oil, and pre-irradiation compression time is purposely made long enough so that approximate equilibrium between compressed rubber pellets and the oil is obtained.[21]

Figure 4 shows room temperature equilibrium volume change for the SBR wire insulation stock. The position indicated by the arrow is the equilibrium swelling point which determines the time of irradiation of companion, compressed elastomeric specimens after compression. Notice that we waited about 70 days to insure the equilibrium point for this SBR compound.

Figure 5 shows the compression set curves for the same SBR wire insulation stock in alkyl diphenyl ether at room temperature. Notice that control-compression set for SBR decreases with increasing immersion time. It is to be noted that although immersion results on compounds are a measure of unrestricted volume change and therefore differ from those on compressed specimens, the rate of volume change should be comparable, that is, equilibrium volume change for an uncompressed and a compressed specimen should be reached at about the same time.

[20] J. R. Beatty and A. E. Juve, "Stress Relaxation of Some Rubber and Synthetic Rubber Vulcanizates in Compression." India RUBBER WORLD, Feb., 1950, p. 121.

[21] J. R. Beatty and A. E. Juve, "Stress Relaxation in Compression of Rubber and Synthetic Rubber Vulcanizates Immersed in Oil." *Ibid.*, Dec., 1952, p. 127.

TABLE 3. THE EFFECT OF STATE OF CURE ON RADIATION-COMPRESSION SET OF HYCAR (NBR) COMPOUND

Cure Time (Min.@ 293° F.)	200% Modulus (psi.)	Radiation Compression Set after 5.23 × 10^9 E/G (C) (%)	Radiation Dose Required For 50% Compression Set [E/G (C) × 10^{-9}]
15	1100	84	0.50
20	1420	78	0.63
35	1790	75	1.18
45	2050	73	1.44
105	2290	67	2.26
210	~2400	68	2.65

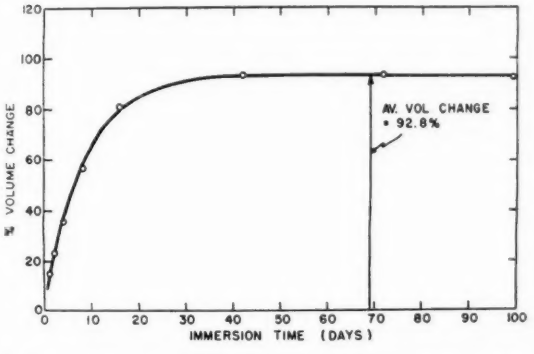

Fig. 4. Volume change of Ameripol (SBR) wire insulation in alkyl diphenyl ether (C_{14} — C_{16}) at room temperature with arrow showing equilibrium point

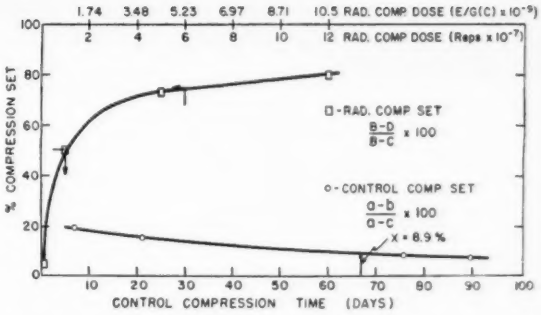
1.74 3.48 5.23 6.97 8.71 10.5 RAD. COMP DOSE (E/G(C) x 10⁻⁹)
2 4 6 8 10 12 RAD. COMP DOSE (Reps x 10⁻⁷)
% COMPRESSION SET
□-RAD. COMP SET
B-D / B-C x 100
o-CONTROL COMP SET
a-b / a-c x 100
X = 8.9 %
CONTROL COMPRESSION TIME (DAYS)

Fig. 5. Radiation-compression set for Ameripol (SBR) wire insulation in alkyd diphenyl ether (C_{14} — C_{16}) at room temperature

Results and Discussion

Gamma radiation is capable of curing most elastomers. An uncured compound, for example, will use part of a radiation exposure dose to complete its cure. Valid comparisons on the radiation resistance of experimental antirad and control stocks can only be made when carefully selected equivalent cures serve as the basis of comparison. Equivalent cure is determined on all compounds primarily from stress-strain *versus* cure-time plots. The compression set equivalent cure is usually selected well up on the stress-strain plateau to insure satisfactory control compression set property.

Figure 6 illustrates how stress-strain properties develop with cure time for a Hycar (NBR) compound. A stress-strain optimum cure was selected as 35 minutes at 293° F. The compression set equivalent cure in this care was selected at 100 minutes.

Radiation Resistance — State of Cure Relation

The dependence of radiation resistance on state of cure can be demonstrated by curing compression set pellets at each cure indicated by the arrows along the time axis and exposing these variously cured pellets to the compression set test. The results are summarized in Table 3. Here it is observed that with an increasingly tighter cure seen in the 200% modulus values the radiation resistance improves as indicated by the decreasing values of radiation-compression set at 5.23 x 10^9 ergs/gram (C) and the increasing values of radiation dose required to effect a 50% set.

These results are further summarized graphically in Figure 7. Here it is seen how radiation dose required for 50% set and radiation-compression set at 5.23 x 10^9 ergs/gram (C) vary as cure times increases. The compression set equivalent cure taken at 100 minutes provides an optimum point in the radiation resistance

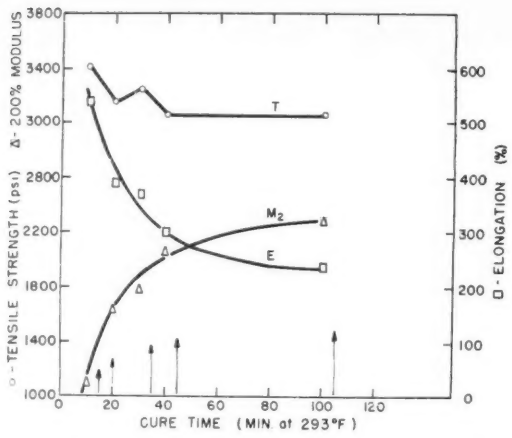

Fig. 6. Stress-strain properties vs. cure time for Hycar (NBR) compound

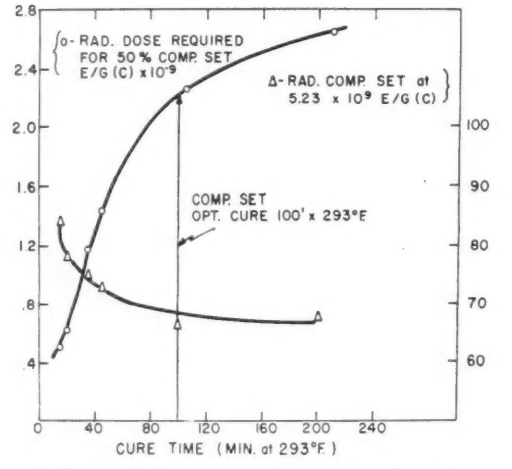

Fig. 7. Radiation-compression set vs. cure time for Hycar (NBR) compound

of this compound, thus further justifying its selection. This selection of a long cure for radiation-compression specimens is not surprising; long cures are commonly given to stocks which must have low compression set in heat service. Developing an equivalent cure in a series of stocks, control plus antirad modifications, is not always an easy matter, especially since antirads in some cases influence the curing system.

Radiation Resistance of Aircraft Compounds

Table 4 summarizes the radiation-compression set of aircraft compounds in air at room temperature based on the average compression set after 5.23 x 10^9 ergs/gram (C) and the approximate dose required for 50% set. The averages were taken over control stocks plus two experimental stocks containing separately Akroflex C and quinhydrone as antirads. These aircraft compounds are listed (top to bottom) for decreasing radiation resistance; both columns of data confirm this order. The dose required for 50% set establishes the critical range for this compression property in these compounds, i.e., 0.67 to 1.6 x 10^9 ergs/gram (C) (or 0.77 to 1.8 x 10^7 reps).

It should be noted that although at least 50% compression set can be effected by approximately 1.6 x 10^9 ergs/gram (C) and that more than 75% set is effected by 5.23 x 10^9 ergs/gram (C), compression set is understandably extra sensitive to radiation, and that based on experimental results many products are still rubbery at doses in the order of 9 x 10^9 ergs/gram (C) after having been irradiated in the compressed state. Further, it is to be noted that these compounds are factory-type recipes wherein each of the many compounding ingredients contribute in a large or small way to the overall radiation resistance of the compound, thus complicating

TABLE 4. RADIATION-COMPRESSION SET OF AIRCRAFT COMPOUNDS

Room Temperature Irradiation and Testing in Air

Compound	Average Compression Set after 5.23 × 10^9 E/G (C) (%)	Approximate Dose Required for 50% Compression Set [E/G (C) × 10^{-9}]
Neoprene (CR) Hose Tube Stock	76	1.60
Packing Compound	78	1.40
Hycar (NBR)-Ameripol (SBR) Hose Tube Stock	78	1.22
Neoprene (CR) Wire Insulation	80	1.51
Hycar (NBR) Fuel Cell Liner Stock	81	1.25
Vinylite Fuel Cell Bladder Stock	83	1.16
Ameripol (SBR) Wire Insulation	84	0.96
Hycar (NBR) Packing Compound	87	0.67

TABLE 5. RADIATION-COMPRESSION SET OF AIRCRAFT COMPOUNDS

Room Temperature Irradiation and Testing in Alkyl Diphenyl Ether (C_{14}-C_{16})

Compound	Average Compression Set after 5.23 × 10^9 E/G (C) (%)	Approximate Dose Required for 50% Set [E/G (C) × 10^{-9}]
Ameripol (SBR) Wire Insulation	74	1.14
Neoprene (CR) Tube Stock	77	1.35
Hycar (NBR)-Ameripol (SBR) Hose Tube Stock	79	1.10
Neoprene (CR) Packing Compound	79	1.45
Hycar (NBR) Fuel Cell Liner Stock	83	1.25
Packing Compound -Vinylite Fuel Cell Bladder Stock	84	0.70
Neoprene (CR) Wire Insulation	84	1.10
	85	1.33

TABLE 6. EQUILIBRIUM VOLUME CHANGE OF AIRCRAFT COMPOUNDS IN ALKYL DIPHENYL ETHER (C_{14}-C_{16})*

R. T. Immersion—No Irradiation—No Compression

Compound	Average Equilibrium Immersion Time (Days)	Average Equilibrium Volume Change (%)
Hycar (NBR) Packing Compound	72	−12.0
Fuel Cell Liner	67	− 9.5
-Vinylite Fuel Cell Bladder Stock	73	+ 3.0
-Ameripol (SBR) Hose Tube Stock	70	+ 7.5
Neoprene (CR) Wire Insulation	67	+39.9
Hose Tube Stock	69	+47.9
Packing Compound	72	+56.6
Ameripol (SBR) Wire Insulation	68	+99.1

* ASTM Method D 471-57T.

TABLE 7. RADIATION-COMPRESSION SET OF CONTROL ASTM OR SUPPLIER TEST COMPOUNDS

Room Temperature Irradiation and Testing in Air

Compound	Compression Set after 5.23×10^9 E/G(C) (%)	Dose Required for 50% Set [E/G(C) $\times 10^{-9}$]
Ameripol (SBR)	66	2.74
Hycar (NBR)	67	2.52
Natural Rubber (NR)	80	1.64
Neoprene (CR)	81	1.49
"Hypalon" 20	75	1.05
Hycar 4021	88	0.84
"Viton" A	100+	0.12
Thiokol ST FA	100+	0.12
	Too soft to test	

side-by-side comparisons of the different elastomers involved.

Table 5 summarizes the radiation-compression set of aircraft compounds in alkyl diphenyl ether at room temperature. The compression set after 5.23×10^9 ergs/gram (C) and the approximate dose required for 50% set are given as averages over control stocks plus two experimental stocks containing separately Akroflex C and quinhydrone as antirads. The overall magnitude of compression set in this oil is about the same as in air although the order has been rearranged somewhat. SBR appears to have slightly improved radiation resistance in alkyl diphenyl ether compared to air. Since SBR has the greatest swell in this oil, which in a sense is its own antirad, this observation seems reasonable.

Table 6 shows the average equilibrium volume change on the aircraft compounds, control plus antirad stocks containing separately Akroflex C and quinhydrone, in alkyl diphenyl ether at room temperature. No irradiation or compression is involved here, only oil resistance. The equilibrium volume change measurements of these aircraft compounds in this ether at room temperature were made to determine the pre-irradiation time of the companion, immersed and compressed specimens whose

TABLE 8. RADIATION-COMPRESSION SET OF SOME ANTIRAD ASTM OR SUPPLIER TEST COMPOUNDS

Room Temperature Irradiation and Testing in Air

Compound	Compression Set after 5.23×10^9 E/G (C) (%)	Dose Required for 50% Set [E/G (C) $\times 10^{-9}$]	50% Set Dose Ratio (Antirad/Control)
Hycar (NBR) Hydroquinone	54	4.35	1.7
Hycar 4021 UOP-88	63	3.73	4.4
Ameripol (SBR) Antiox 4010	59	3.57	1.3
Neoprene (CR) Antiox 4010	75	2.15	1.4
Natural Rubber (NR) UOP-88	74	2.19	1.3
"Hypalon" 20 Antiox 4010	83	1.48	1.4
"Viton" A UOP-88/Antiox 4010 (50/50)	93	0.71	5.9
Thiokol ST Antiox 4010	100+	0.26	2.2

radiation-compression-set results are given in Table 5. These volume change measurements showed that, for oil resistance, Hycar (NBR) >> Neoprene (CR) >> Ameripol (SBR).

Elastomers Compared

Table 7 shows the radiation-compression set results of the various elastomers that were formulated in comparative control recipes, i.e., compounds without antirads. They are rated from top to bottom for radiation resistance during compression, using the two selected decay points. The dose range for 50% compression set in these compounds is 0.12 to 2.74 x 10^9 ergs/gram (C); the compression set after 5.23 x 10^9 ergs/gram (C) ranges from 66 to 100%. SBR is the most inherently resistant polymer tested; all polymers except Thiokol polysulfide rubbers showed predominant cross-linking and therefore hardening with radiation exposures.

Table 8 shows the range of effectiveness of antirads in inhibiting radiation effects on elastomers compounded in the same comparative recipes.

For example, a dose of 4.35 x 10^9 ergs/gram (C) is required to effect 50% compression set on the NBR-hydroquinone compound, a gain over its control given in the previous table of 70% shown by the dose ratio of antirad stock to control stocks in the last column. The next highest dose required for 50% compression set was Hycar 4021 containing UOP 88; its improvement was 340% over its control. The indicated doses required for 50% set are the maximum values that we have obtained on these standard test compounds, the range being from 0.26 to 4.35 x 10^9 ergs/gram (C). The minimum radiation-compression set after 5.23 x 10^9 ergs/gram (C) was obtained on the Hycar (NBR) hydroquinone stock, i.e., 54%.

Rate of Property Decay Equation

A major problem in the current work is that of (1) comparing radiation resistance of elastomeric compounds, (2) determining the degree of change imparted to the radiation-resistance of a compound by an additive, and (3) the degree of reproducibility in the test method. The comparisons reported, thus far, on compression set testing were obtained on the basis of point observations along the decay curves of the compounds. These observations are useful for screening of various compounds, but they do not give a precise picture of how overall decay takes place. The rate of property decay of compounds would be a far better basis for comparison. The irradiation decay of compounds measured by compression set appears to be described in some cases by the following regression equation over the dose range 0.87 to 105 x 10^5 ergs/gram (C).

$$S = -Ae^{-BR} + S_e$$

S = radiation-compression set at any gamma radiation exposure dose R
S_e = radiation compression set at R = ∞
A = $S_e e^{-a}$
C = constant
B = rate constant

This empirical relation is fitted to the experimental data using the method of least squares and can be conveniently graphed by plotting log (1-S/S_e) *vs.* radiation dose (R). Here, the fraction of radiation compression set yet undeveloped is directly related to radiation dose R. Figure 8 summarizes some of the satisfactory fits of this empirical equation to experimental points which we have obtained on some compounds. Here log (1-S/S_e) is plotted against radiation dose for the Hycar (NBR) fuel cell liner control stock plus three antirad variations, i.e., α-naphthylamine, hydroquinone, and Antiox 4010 stock. The experimental points are seen to be in good agreement with the equation points. The antirad stocks are characterized by slower slope, i.e., lesser B values, and displacement to the right of the control curve, i.e., higher A values. These results are given in Table 9 where, for example the Antiox 4010 stock has a B value which is 33% smaller and an A value, 28% larger than the respective control values.

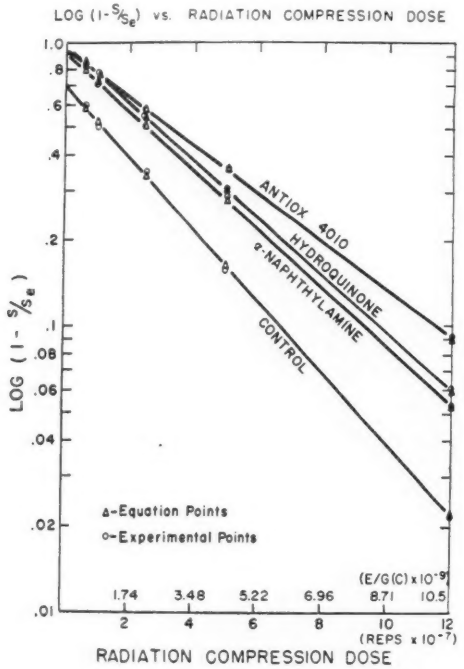

Fig. 8. Radiation-compression set of Hycar (NBR) fuel cell liner stock with and without antirads in air at room temperature

TABLE 9. SOLUTIONS TO RADIATION-COMPRESSION SET EQUATION

$$S = -Ae^{-BR} + S_e$$

FOR HYCAR (NBR) FUEL CELL LINER STOCK

	A	B*	S_e
Control	0.64	3.33	0.91
αNaphthylamine	0.79	2.67	0.87
Hydroquinone	0.79	2.67	0.82
Antiox 4010	0.82	2.22	0.88

* The units for constant B are $[10^{10}\ E/G(C)]^{-1}$.

Presently a statistical analysis of error of test method is being conducted. Data to date indicate that reproducibility is in the order of ±5-10%.

Summary and Conclusions

The results presented in this paper provide engineering-type data on elastomeric compounds in compression in a gamma radiation field. Compression set is a sensitive measurement of the net result of the processes of excitation, bond cleavage, cross-linking, relaxation, oxidation, etc. that take place when an elastomer is irradiated. An attempt has been made to establish "control" performance of various types of compounds under such environmental conditions and to inhibit their effect. This work generally points out the need of more radiation-resistant elastomers and more effective antirads.

A modified method for determining compression set of irradiated samples was developed. It is a modified version of ASTM D 395-55, Method B, that differs in size of pellet and in calculations to eliminate the effect of pre-exposure set. The method for determining the correction was shown.

Acknowledgment

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Rubber Recording Sleeves for Telephone Answering Devices

Rubber sleeves developed to replace plastic tape for continuous, heavy-duty service

By H. PETERS, W. R. GOEHNER, W. H. LOCKWOOD, and T. De BENEDICTIS

Bell Telephone Laboratories, Murray Hill, N. J.

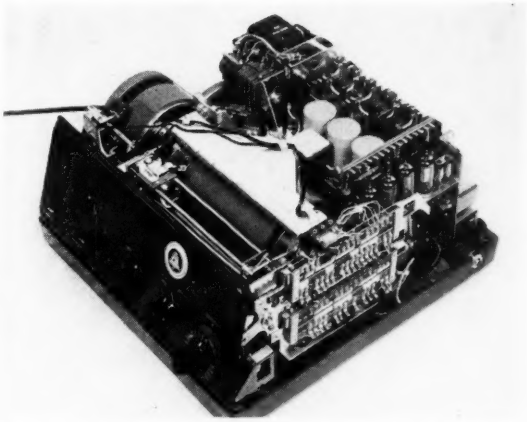


Fig. 1. Bell Telephone System answering set which uses magnetic rubber sleeves

THE art of magnetic recording is now more than 50 years old. Progress in this field was very slow at the start because of a lack of suitable devices to amplify the low signal levels and because steel wire and metal tape recording media were bulky and difficult to use. About 10 years ago the progress was greatly accelerated by the development of plastic tape coated with a magnetic powder, the transmission characteristics of which were found to include a broad frequency bandwidth, a large signal-to-noise ratio, and low distortion.

The new coated plastic-tape recording material proved to be much more convenient to use and much easier to manufacture than the solid metal recording media, and the production of coated magnetic tape is now a large industry. It is produced in many types and is used on magnetic recording devices designed for a wide range of applications.

Coated magnetic tapes are made by covering a plastic base with magnetic iron oxide powder dispersed uniformly in a liquid binder, which holds the oxide in place on the base material. The powder is generally gamma Fe_2O_3, which has an average particle size of about one micron. Approximately 300,000,000 particles are magnetized in a recording of one-second duration. The dispersion must be carefully prepared to obtain the desired magnetic characteristics. For example, granularity of the coating is one cause of random noise. To obtain the required noise level, usually 60 decibels (db.)[1] below the fully modulated signal output voltage, a coating of fine particle structure must be produced.

While the coated materials give excellent performance for ordinary recording use, it was found that the Bell System continuous-duty type of service required a more stable and durable recording material. The Bell Laboratories developed a new material[2] for these services which survived millions of operations under conditions where coated tapes wore out in a few thousand operations.

The investigation reported in this paper deals with the dispersion of magnetic iron oxide in a ⅛-inch thick, vulcanized elastomeric base, resilient enough to permit the scanning head to make the required contact at relatively low head pressures. The material can be fabricated in the form of disks or cylinders and is used on Telephone Answering Sets (see Figure 1) and other Bell System heavy-duty announcing equipment.

The molded magnetic cylinders or bands are an active part of the transmission system. The signal is stored in the magnetic medium, and the required signal output is available until it is necessary to erase and replace it with another announcement. The duration of the storage time may be only a few minutes or as much as several years.

The requirements for production of the elastomeric magnetic bands therefore include the need of meeting transmission signal and noise limits in addition to the special physical requirements which include resilience, hardness, permanent set, ozone and abrasion resistance, low coefficient of friction, and a molded surface free of bloom for at least ten years. Data will be given to show how these requirements have been met by development of a vulcanized "Hypalon"[3] rubber, containing magnetic iron oxide.

Experimental Details

Compounds were mixed in accordance with pro-

[1] "The decibel is a unit of level which denotes the ratio between two quantities that are proportional to power; the number of decibels corresponding to the ratio of two amounts of power is 10 x log to the base 10 of this ratio." "Handbook of Noise Control," Edited by Cyril M. Harris. McGraw-Hill Book Co., Inc., New York (1957).

[2] J. Z. Menard, *Bell System Tech. J.*, May, 1952, pp. 530-540.

[3] Chlorosulfonated polyethylene, E. I. du Pont de Nemours & Co., Inc., elastomer chemicals department, Wilmington 98, Del.

Fig. 2. Jig for measuring stress relaxation. Rubber band is stretched 6% over the metal bar, and force required to raise bushing from bar is measured periodically

TABLE 1. "HYPALON"-MAGNETIC IRON OXIDE COMPOUNDS; ACCELERATOR CONSTANT, MgO VARIABLE

	Parts by Weight		
Compound No.	229	232	233
"Hypalon" 20	88.0	88.0	88.0
Magnetic iron oxide*	175.0	175.0	175.0
Magnesium oxide, extra light calcined	20.0	15.0	10.0
Dibutyl phthalate	15.0	15.0	15.0
Staybelite Resin†	2.5	2.5	2.5
Tetrone A‡	1.5	1.5	1.5
Cured 20 Minutes at 307° F.§			
Tensile, psi.	2025	1830	1750
Elongation, %	130	165	175
Hardness, Shore A	79	80	80
Permanent set, in.	6/64	8/64	8/64
Mooney scorch, MS at 250° F.			
Min. to 5-point rise	7.5	18.0	20.0
10-point rise	12.5	28.5	30.5

* Acicular gamma red oxide, C. K. Williams & Co., Inc., East St. Louis, Ill.
† Ester of hydrogenated rosin, Hercules Powder Co., Wilmington, Del.
‡ Dipentamethylene thiuram tetrasulfide, du Pont, elastomer chemicals department.
§ A range of cures 20, 30, and 45 minutes at 307° F. was run, of which 20 minutes appeared to be the optimum.

cedures described in ASTM[4] D 15-57T. Curing agents and plasticizers were incorporated during the last five minutes of mixing.

Physical Testing

Curing of test sheets and preparation of test samples were carried out in accordance with ASTM D 15-57T. Tensile strength, Shore hardness, elongation, scorch, heat aging, and permanent set were measured in accordance with ASTM D 412-51T, D 676-58T, D 412-51T, D 1077-55T, D 573-53, and D 412-41, respectively.

Relaxation

A jig[5] consisting of a metal bar and bushing (Figure 2) was developed for measuring stress relaxation. A rubber band, cut from a molded sleeve, was stretched 6% over the jig. The force required to raise the bushing from the base of the metal bar at various times from zero to the duration of the test was measured.

Measurements were made over a period of three years, and the results are reported as the percentage of the original force lost for the various periods of time the rubber was subjected to stress relaxation.

TABLE 2. "HYPALON"-MAGNETIC IRON OXIDE COMPOUNDS; MgO CONSTANT, ACCELERATOR VARIABLE

	Parts by Weight		
Compound No.	229	231	230
"Hypalon" 20	88.0	88.0	88.0
Magnetic iron oxide	175.0	175.0	175.0
Magnesium oxide, E.L.C.	20.0	20.0	20.0
Dibutyl phthalate	15.0	15.0	15.0
Staybelite Resin	2.5	2.5	2.5
Tetrone A	1.5	1.25	1.0
Cured 20 Minutes at 307° F.*			
Tensile, psi.	2025	2010	2080
Elongation, %	130	140	150
Hardness, Shore A	79	82	80
Permanent set., in.	6/64	4/64	7/64
Mooney scorch, MS at 250° F.			
Min. to 5-point rise	7.5	15.0	15.5
10-point rise	12.5	—	30.0

* A range of cures 20, 30, and 45 minutes at 307° F. was run, of which the 20-minute cure appeared to be optimum.

Ozone Resistance

Samples were mounted in accordance with ASTM D 518-57T, Procedure A, and tested in accordance with ASTM D 1149-55T at 120° F. for various periods of time.

Signal and Noise

A 1,000-cycle signal was recorded and reproduced on a magnetic recording sleeve. The 1,000-cycle signal was then amplified and measured. Following this measurement, the 1000-cycle signal was erased, and the residual noise was measured at the same amplification as the 1,000-cycle signal level was determined. The relative value of the 1,000-cycle signal with respect to the value of noise is a measure of the suitability of the magnetic medium as a transmission device.

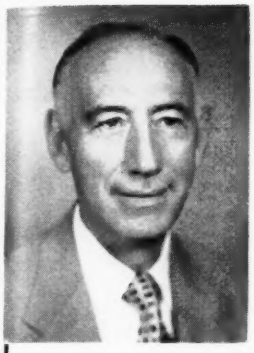
Abrasion and Friction

Abrasion and friction were determined in accordance with the equipment shown in Figure 4, the use of which is explained later in this paper. Tests were made at 75° F. and 75% relative humidity.

Compounding Investigation

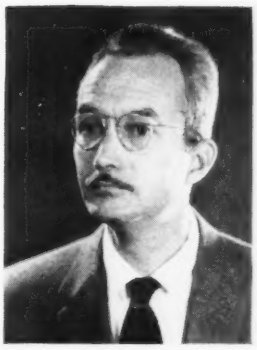
Prior to the development of "Hypalon" compounds, natural rubber (NR), neoprene (CR), butyl (IIR), mixtures of polyvinylchloride and nitrile rubber, and PVC plastisol compounds were evaluated as a possible material for telephone recording devices. All of these

[4] American Society for Testing Materials, Philadelphia 3, Pa.
[5] Developed by I. L. Hopkins, Bell Telephone Laboratories.



H. J. Peters

W. R. Goehner



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William R. Goehner, a member of the technical staff of Bell Labs and presently engaged in the development of announcement and recording devices, was employed in the engineering department of Western Electric Co. from 1919 to 1925. He joined Bell Labs in 1925.

Mr. Goehner is a member of the Acoustical Society of America and the Society of Motion Picture & Television Engineers and has been granted six patents in the fields of optics, photography, and magnetic recording.

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materials were unsatisfactory for one reason or another. Most of them exhibited poor abrasion and frictional noise produced by the recording head gliding over the surface of the vulcanized sleeve.

The noise level in these rubber compounds was lowered by incorporating waxes and oils of limited solubility which would migrate and lubricate the surface of the rubber. Unfortunately, the rate of migration was uncontrollable, and wax piled up under the head and caused the head to raise and lose contact with the recording rubber surface, with resultant unbearable loss in signal strength.

"Hypalon" 20[6] differs from most conventional rubbers. It is a saturated molecule and does not depend upon sulfur for vulcanization. It is chlorosulfonated polyethylene with a molecular weight of about 20,000. The polymer contains 1.3 to 1.7% sulfur and 26 to 29% chlorine, or approximately one chlorine for each seven carbon atoms in the molecule and one sulfonyl chloride group for every 90 carbon atoms.

As shown in Tables 1-4 studies were made to evaluate the physical properties of "Hypalon"-magnetic iron oxide compounds, accelerated with dipentamethylenethiuram tetrasulfide (Tetrone A) and vulcanized with lead or magnesium oxide.

Table 1 shows the effect of varying the magnesium oxide curing agent and keeping the accelerator Tetrone A constant. All of the compounds meet the requirements of a minimum tensile strength of 1,700 psi., a minimum elongation of 100%, a Shore hardness of 80 ±5, and a maximum permanent set of ⅛-inch. Compounds 232 and 233 are preferred because of superior processing safety (Mooney scorch).

One can conclude that at least 10 parts of magnesium oxide are required with 1.5 of Tetrone A. Nevertheless, it may be possible that the magnesium oxide could be reduced below 10 parts and the Tetrone A be raised above 1.5 parts to obtain optimum proper-

[6] Du Pont elastomer chemicals department, Report 55-3, February, 1955.

TABLE 3. "HYPALON"-MAGNETIC IRON OXIDE COMPOUNDS; ACCELERATOR CONSTANT, PbO VARIABLE

		Parts by Weight		
Compound No.		322	386	385
"Hypalon" 20		88.0	88.0	88.0
Magnetic iron oxide		175.0	175.0	175.0
Lead oxide (litharge)		35.0	25.0	15.0
Dibutyl phthalate		11.0	11.0	11.0
Polyethylene 8406*		4.0	4.0	4.0
Staybelite Resin		2.5	2.5	2.5
Tetrone A		1.5	1.5	1.5
	Min. at 307° F.			
Tensile, psi.	5	2125	—	—
	20	2250	1950	1925
	30	2200	1900	1825
Elongation, %	5	130	—	—
	20	120	160	160
	30	120	160	170
Hardness, Shore A	5	81	—	—
	20	85	82	83
	30	85	83	83
Permanent set, in.	5	5/64	—	—
	20	5/64	10/64	9/64
	30	5/64	9/64	9/64
Mooney scorch, MS at 250° F.				
Min. to 5-point rise		2.5	3.0	3.0
10-point rise		3.0	3.5	3.5

* Allied Chemical Corp., plastics & coal chemicals division, New York 6.

TABLE 4. "HYPALON"-MAGNETIC IRON OXIDE COMPOUNDS; PbO CONSTANT, ACCELERATOR VARIABLE

	Parts by Weight				
Compound No.	322	381	382	383	384
"Hypalon" 20	88.0	88.0	88.0	88.0	88.0
Magnetic iron oxide	175.0	175.0	175.0	175.0	175.0
Lead oxide (litharge)	35.0	35.0	35.0	35.0	35.0
Dibutyl phthalate	11.0	11.0	11.0	11.0	11.0
Polyethylene 8406	4.0	4.0	4.0	4.0	4.0
Staybelite Resin	2.5	2.5	2.5	2.5	2.5
Tetrone A	1.5	1.0	0.5	0.25	—
Cured 20 Minutes at 307° F.*					
Tensile strength, psi.	2250	2225	2100	1350	300†
Elongation, %	120	110	120	160	300†
Hardness, Shore A	85	87	85	82	72‡
Permanent set, in.	5/64	4/64	7/64	20/64	—
Mooney scorch, MS at 250° F.					
Min. to 5-point rise	2.5	3.0	2.5	2.5	24.0
10-point rise	3.0	3.5	3.0	3.0	—

* A range of cures 20, 30, and 45 minutes was run, of which 20 minutes appeared to be optimum.
† 30-minute cure.
‡ 45-minute cure.

ties. It is essential, however, to use less than 2.0 parts of Tetrone A; otherwise the accelerator will bloom to the surface of the "Hypalon" and interfere with the magnetic recording.

Table 2 shows the effect of varying the accelerator, Tetrone A, and holding the curing agent, magnesium oxide, constant. Again, all of these compounds meet the necessary requirements. Compounds 230 and 231

TABLE 5. "HYPALON"-MAGNETIC IRON OXIDE COMPOUNDS, PHYSICAL PROPERTIES, VARIOUS CURING TEMPERATURES

"Hypalon" 20	88.00
Magnetic iron oxide	175.00
Dibutyl phthalate	15.00
Magnesium oxide E.L.C.	20.00
Staybelite Resin	2.50
Tetrone A	1.50

Cure Time, Min.	Temperature, °F.	Tensile Strength, Psi.	Elongation, %	Hardness, Shore A
20	270	1600	140	77
30	270	1980	120	80
45	270	2100	110	79
20	280	1720	120	81
30	280	1700	95	81
45	280	2150	100	81
20	290	2100	120	80
30	290	2100	120	80
45	290	2125	110	80
30	300	2120	110	78
30	307	2100	110	80
30	320	2140	110	78

are preferred because of their improved scorch resistance. The results show that at least one part of Tetrone A is necessary to activate 20 parts of magnesium oxide. It is possible, however, that quantities less than one part of Tetrone A might be sufficient to obtain optimum physical properties.

Curing studies were also made with lead oxide and Tetrone A in which the oxide was varied and the Tetrone A kept constant. The results in Table 3 show that compound 322 with 35 parts of lead oxide and 1.5 parts of Tetrone A meets the necessary requirements. Compounds with 25 and 15 parts of lead oxide were unsatisfactory. The limiting value for the oxide lies between 35 and 25 parts. The processing safety (scorch) is marginal, and the temperature of mixing must not exceed 200° F. Low molecular weight Polyethylene 8406 is added to the compound to facilitate processing and removal of the vulcanized sleeve from the mold. Lead oxide cures produce optimum properties in five minutes, as compared to 20 minutes for magnesium oxide cures, expecially when the former are examined with special reference to the important property of permanent set.

Table 4 shows the results when the accelerator is a variable and the lead oxide is held constant. With 35 parts of oxide, as little as 0.5-part of Tetrone A is necessary to obtain the desired vulcanizate physical properties. The scorch resistance at this low level of accelerator concentration is unfortunately no better than compounds containing larger amounts of Tetrone A.

Table 5 illustrates the time-temperature relation for curing "Hypalon" compounds with magnesium oxide and Tetrone A. Optimum properties are obtained with 20 minute cures at 290° F. Based on the values shown in Table 3, however, lead oxide should produce much shorter cures at the same temperature.

TABLE 6. PROPERTIES OF ACICULAR GAMMA RED IRON OXIDE

(1) Chemical Composition	
Total iron as Fe_2O_3	98.5%
Water solubles	0.8%
Moisture content	0.3%
Sulfur	0.3%
pH	3–7
(2) Physical Properties	
Sieve Analysis	
Retained on 325 mesh sieve	1.5%
Mean particle diameter	1.0 micron
(3) Magnetic Properties	
Coercive force	240–280 Oersteds*
Remanence	1700 Gausses†

* Unit of magnetic force.
† Unit of magnetic induction.

Iron Oxide Properties vs. Vulcanizate Properties

The acicular gamma red iron oxide (Fe_2O_3) with a mean particle length of one micron used in this work is obtained from C. K. Williams & Co., Inc. The iron oxide mixes readily with "Hypalon" and can be easily magnetized or demagnetized.

The moisture content and the pH of the iron oxide greatly affect the processability and rate of cure of the magnetic rubber compounds. A moisture content greater than 0.5% produces a scorchy compound that is difficult to mold. On the other hand, an iron oxide with an acidic pH retards the cure and lowers the physical properties. The preferred oxide is one with a moisture content well below 0.5% and a neutral pH.

The chemical, physical, and magnetic properties of this iron oxide are shown in Table 6, and the effect of its pH on the physical properties of a magnetic rubber compound is shown in Table 7.

Effect of Iron Oxide on Signal and Noise

The signal strength of the recording sleeve is a function of the magnetic iron oxide concentration (Figure 3) and is independent of the curing system. The iron oxide content should not exceed 200 parts by weight on 88 parts of "Hypalon" (28.4 parts by volume) since larger amounts cause processing difficulties (scorch) and additional noise. Magnesium oxide vulcanizates are noisier than those compounds vulcanized with lead oxide.

The ideal recording sleeve is usually one which has a large signal-to-noise ratio. It has been found that additional milling of the iron oxide produces better dispersion, which, in turn, increases the signal-to-noise ratio. The results in Table 8 show that the signal remains the same for both types of vulcanizates, but the noise level for a lead vulcanizate is improved 27% after remilling. Compounds vulcanized with magnesium oxide, unfortunately show practically no improvement after remilling for the same period of time.

Ozone Resistance and Heat Aging

A magnetic recording sleeve or band, stretched 6% over a metal drum, is required to last at least 10 years without maintenance. Most elastomers under these stressed conditions are vulnerable to ozone cracking. Imperfections or visible cracks on the surface of the sleeve would cause an undesirable momentary interruption of the recorded signal. "Hypalon," because of its lack of chemical unsaturation (double

TABLE 7. EFFECT OF IRON OXIDE pH ON MAGNETIC RUBBER COMPOUND PROPERTIES

	Unwashed Magnetic Oxide	Washed Magnetic Oxide
pH	3.1	7.1
Volatility (105° C.), %	0.013	0.011
Mooney scorch, MS at 250° F.		
5 point rise—min.	8.5	6.0
10 point rise—min.	10.5	8.0
Tensile strength, psi.	1660	2120
Elongation, %	205	145
Hardness, Shore A	75	77
Permanent set, inches	0.156	0.047
Abrasion (Taber), gms.	0.4705	0.4088
Signal level, db*	68.0	67.2
Noise level, db*	28.0	33.6

* Relative voltages.

TABLE 8. EFFECT OF MILLING ON SIGNAL AND NOISE

	Relative Output Voltage in Decibels	
	Signal	Noise
MgO standard mix (15 min.)	67.5	33.0
Remilled after one day	67.5	33.0
One day and 3 days	67.2	28.6
PbO standard mix	67.2	29.6
Remilled after one hour	67.2	24.0
One hour and 6 hours	67.2	22.4
One hour and 24 hours	67.2	21.7

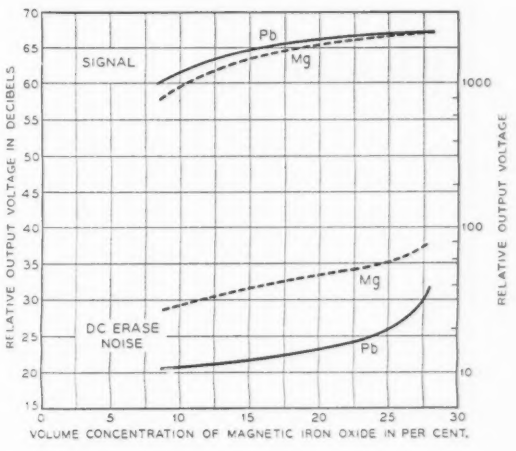


Fig. 3. Effect of magnetic iron oxide content on output voltage of MgO and PbO rubber sleeves

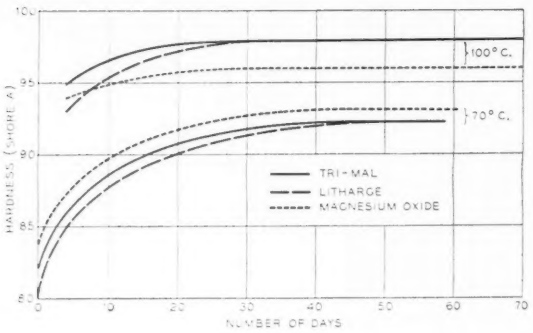


Fig. 4. Effect of heat aging on the hardness of "Hypalon"-magnetic iron oxide vulcanizates

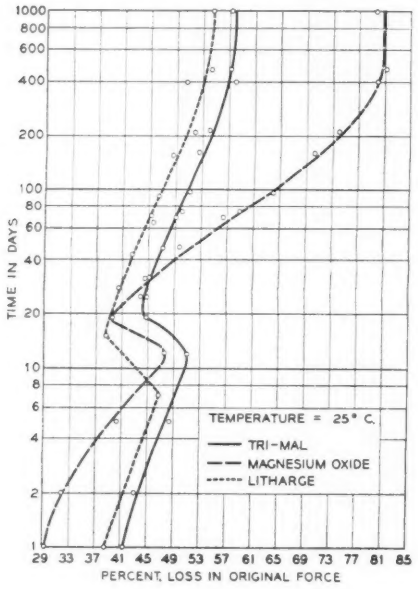


Fig. 5. Stress relaxation or % loss in force of "Hypalon"-iron oxide compounds vulcanized with three different curing systems

bonds), is able to resist ozone degradation. Exposure to accelerated ozone tests shows no degradation after one year's exposure—by comparison natural rubber under the same test conditions would show ozone cracking after a few hours' exposure.

In addition to having excellent ozone resistance, "Hypalon" is resistant to heat aging. The results in Figure 4 show that an increase in hardness over a period of 70 days with three different curing systems at 70 and 100° C. is approximately 10 and 5 Shore A durometer points, respectively. The hardness increase is not excessive, and the loss of elongation is only 30%. Very few rubbers under comparable conditions could match this excellent performance.

Stress Relaxation

Elastomers held at constant elongation relax through stress decay. Recording sleeves, stretched over a metal

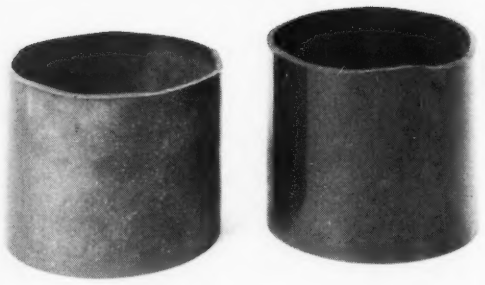


Fig. 6. Cured "Hypalon"-magnetic iron oxide sleeves after exposure to 75 to 120° F. temperatures and 90% relative humidity for three months. MgO compound on left; Tri-Mal compound on right

drum, behave in a similar manner. Over long periods of stress relaxation the sleeves or bands can loosen and fall off the drum. Proper compounding can minimize this effect.

Figure 5 shows the stress relation of "Hypalon" with three different curing systems. Tri-Mal[7] (tri basic lead maleate) and litharge (lead oxide) behave alike and are both superior to magnesium oxide cures. The lead oxide cures lost approximately 57% of the original force, as compared to 81% loss for the magnesium oxide cures.

Humidity and Water Absorption

A recording sleeve must be smooth and free of imperfections. It must be free of migrating ingredients and be unaffected by excessive humidity. The recording sleeves must also be capable of withstanding low temperatures (—40° F.) which may be encountered during transportation and storage.

Figure 6 compares two "Hypalon" sleeves, one cured with magnesium oxide, and the other with Tri-Mal. Samples were cycled from 75 to 120° F. and kept at 90% relative humidity for three months. White specks appeared on the Hypalon sleeve cured with magnesium oxide. "Hypalon" reacts with magnesium oxide to form magnesium chloride, which is hygroscopic. On exposure to humidified air part of the magnesium chloride is converted to white specks of magnesium carbonate. The salt residue becomes sufficiently thick to cause the metal head to lose contact with the recording surface. Lead maleate cures of "Hypalon" were relatively unaffected by humidity.

Again lead maleate and magnesium oxide cures of "Hypalon" were compared at 42 and 100% humidity (Figure 7). Magnesium oxide vulcanizates gained 1% and 9% moisture at 42 and 100% humidity, respectively. Lead maleate cures were essentially unaffected.

Abrasion, Friction, and Noise

Abrasion is a difficult property to evaluate. ASTM methods are available, but the results seldom cor-

[7] National Lead Co., New York 6, N. Y.

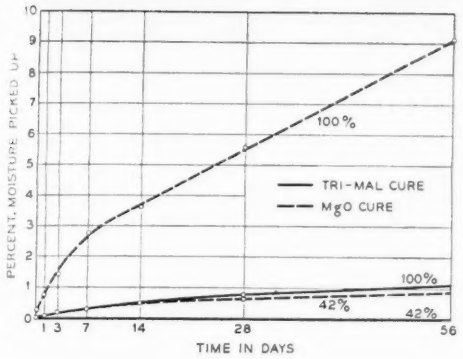


Fig. 7. Moisture absorption at room temperature and 42 and 100% relative humidity of "Hypalon"-iron oxide vulcanizates cured with lead maleate and magnesium oxide

relate with those found in practice. Figure 8 illustrates a piece of equipment for measuring abrasion. The results are comparable with those obtained with a telephone answering set.

As shown in the photograph, the metal recording head is weighted down in contact with the surface of a rotating rubber sleeve. The head load is 40 grams, and the test cycle is for seven days at 75° F. and 75% relative humidity. A satisfactory sleeve shows practically no visual wear during this time, while an unsatisfactory sleeve shows considerable wear after a few hours. Natural rubber and many synthetic rubbers have poor abrasion properties in comparison with "Hypalon." The abrasion resistance of "Hypalon" is the same whether cured with magnesium or lead oxide.

The abrasion test has another interesting facet to its usefulness. It can be used to determine qualitatively friction and noise. Friction increases appreciably when the metallic head gouges a rubber having poor resistance to abrasion. A comprehensive report[8] on this subject has described the effect of humidity, temperature, normal force, and velocity upon static and kinetic co-efficient of friction between a recording head and vulcanized "Hypalon" rubbers.

Solution Coatings

Molded magnetic "Hypalon" sleeves for telephone answering sets have a wall thickness of ⅛-inch. In some applications a thinner wall would offer some advantages; however, it becomes more difficult to fill a mold for a sleeve with a reduced wall thickness. During the transfer molding operation, the friction becomes greater, more heat is generated, and the compound sets up before the mold can be filled.

Thin walls are made best with solution coatings. A toluene solution, containing 10-20% solids, can be sprayed or dipped on the surface of an inexpensive rubber base. "Hypalon" coatings adhere best to a molded surface of a polar rubber such as a copolymer of butadiene and acrylonitrile. A thickness of 0.003-inch to 0.005-inch appears to be adequate to resist abrasion. A thin magnetic coating of "Hypalon" offers the following advantages: (1) Stronger signal because greater loadings of magnetic iron oxide can be incorporated in a solution mixture. (2) DC signal erase is more efficient. Smaller erasing magnets requiring less circuitry may be used.

[8] Unpublished data, R. F. Westover, Bell Telephone Laboratories.

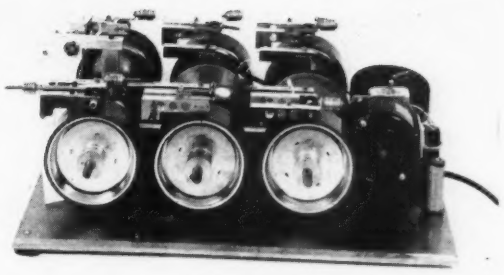


Fig. 8. Special apparatus for measuring abrasion of rubber recording sleeves. Recording head is weighted down in contact with rotating sleeve

Summary and Conclusions

"Hypalon" magnetic recording sleeves have been developed for recorded announcement and message recording devices. Noise levels of about 45 db. below the signal, including all other sources of noise such as amplifier noise, magnetic interference, etc., have been achieved. "Hypalon" magnetic recording sleeves have been used on automatic announcement machines over the past five-year period where the same announcement has been repeated more than 3,000,000 times without failure of the recording medium.

Sleeves vulcanized with magnesium oxide are unsuitable for humid locations; while sleeves vulcanized with lead oxide are relatively unaffected. Optimum physical properties such as tensile strength, elongation, hardness, permanent set, stress relaxation, and a minimum friction are obtained with 35 parts of lead oxide and with as little as 0.5-part of dipentamethylenethiuram tetrasulfide (Tetrone A).

Acidic iron oxides retard the rate of cure. The signal output is a function of the iron oxide concentration. Approximately 200 parts of iron oxide, (28.4 pts./volume) based upon 88 parts of polymer, represent the maximum amount that can be added to the mix without scorching. Additional dispersion of the iron oxide through milling lowers the noise level.

Thin coatings can be produced by spraying or dipping "Hypalon"—magnetic iron oxide solutions on inexpensive molded rubber sleeves. Higher signal output is possible through the greater loadings of iron oxide obtainable with solution coatings, and the DC erase of the signal is more efficient.

Acknowledgments

We are indebted to R. A. Miller and W. J. Brown for counsel and suggestions and to I. L. Hopkins and R. F. Westover for help in designing test equipment.

Carbon Blacks—
Why, Where, How to Use Them

By I. DROGIN

United Carbon Co., Inc., New York, N. Y.

TO MAKE the best use of carbon blacks you should know in advance the relevant factors of the particular job: the economic aspects, the equipment available, the type of stock to be mixed, and what is expected of the final compound.

The basis of the decision is a knowledge of the blacks; what each will do; how to mix them for maximum effectiveness; and what each costs.

Table 1 lists 14 types of carbon black varying in degree of reinforcement, ease of processing, and price. With the exception of the conductive channel, CC, current prices range from 4.5 to 11.5¢ per pound and correspond to the degree of reinforcement each black imparts. The 12 blacks starting from SAF, going through to MT, increase in particle size and decrease in reinforcement as you go down the list. The last two, CF and CC, are conductive blacks and are useful in products where electrical conductivity is important.

Last year nine companies produced nearly two million pounds of carbon black. (See Figure 1 for breakdown by type.) Quality-controlled carbon black produced by these companies enables users in the rubber industry to turn out end-products of desired quality. Clearly the rubber industry is in a position to obtain its carbon black from a number of sources. The names of the nine companies producing carbon black are listed in Table 2.

TABLE 1. TYPES OF CARBON BLACK AND THEIR PRICES

Type		Current Price Per Pound*
SAF	Super Abrasion Furnace	$0.115
ISAF	Intermediate Super Abrasion Furnace	0.0925
HAF	High Abrasion Furnace	0.0775
EPC	Easy Processing Channel	0.085
MPC	Medium Processing Channel	0.085
FEF	Fast Extrusion Furnace	0.0675
FF	Fine Furnace	0.0725
GPF	General-Purpose Furnace	0.06
HMF	High Modulus Furnace	0.0625
SRF	Semi-Reinforcing Furnace	0.0575
FT	Fine Thermal	0.0575
MT	Medium Thermal	0.045
CF	Conductive Furnace	0.0925
CC	Conductive Channel	0.26

*F.o.b. plant, carloads or truckloads, bags.

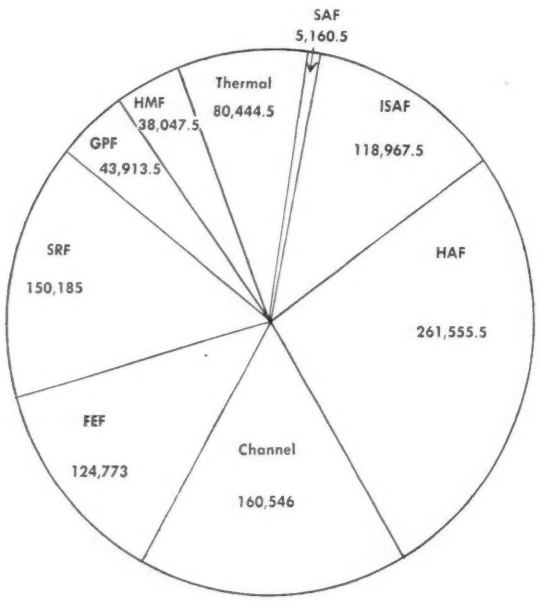


Fig. 1. Carbon black production in 1959: 983,593 tons

Reasons for Use of Carbon Blacks

- Low cost.
- Wide selection of types.
- Broad reinforcement range.
- Many sources of supply.
- Quality-controlled end-product.
- Dependable uniformity.
- Chemical inertness.
- Unmatched for combination of quality and low cost.
- Best to produce tough, abrasion-resistant and flex-resistant products.

No other compounding ingredient has yet been found that is both so efficient and so low priced as carbon black. Finely divided silica may, under certain conditions, impart higher reinforcement values, but such ingredients are more costly. Conversely, other ingredients which may compare favorably in price with carbon black have lower reinforcing values. For products which must be tough and resistant to abrasion and flex, carbon black is the invariable choice.

Carbon black fulfills six important functions:

1. Reinforcing pigment.
2. Ordinary filler. This is the role of thermal blacks.
3. Coloring agent.
4. Processing aid. Improves tubing and calendering. The FEF-type black is particularly suited for this function.
5. High physical qualities: toughness, hardness, tensile strength, resistance to tear, wear, and flex, and electrical conductivity.
6. High loadings can be achieved without unduly increasing stiffness.

The above properties can be obtained by a selection of the proper type of black. The reinforcing types (SAF, ISAF, HAF, Channel) yield rubber physical properties such as toughness, hardness, high tensile strength, and improved resistance to tear, wear, and flex. The conductive blacks contribute electrical conductivity. For high loadings without undue stiffness, the thermal (MT and FT) types and, to a lesser extent, SRF are used.

While all types of carbon black are used in natural rubber and SBR, in other rubbers only specific blacks are used. Figure 2 lists the rubbers and the blacks normally compounded in them. The special problem of latex (SBR) black masterbatch is also included.

TABLE 2. PRODUCERS OF CARBON BLACK

Cabot Corp.
Columbian Carbon Co.
J. M. Huber Corp.
Phillips Chemical Co.
Sid Richardson Carbon Co.
Shell Chemical Co.
Thermatomic Carbon Co.
United Carbon Co., Inc.
Witco Chemical Co., Inc. (Continental Carbon Co.)

Carbon Black in Tires

Tire manufacture utilizes about 60% of all our rubber. Different types of black are used in the various parts of a tire: undertread, breaker, cushion, inner ply, outer ply, and squeegee (see Figure 3). The type of carbon black used is, of course, governed by the requirements, service conditions, economy considerations, tire price, mileage contracts, how the black will be used, available mixing equipment, factory processability, etc. Factors such as ability of the tire to withstand high speeds under heavy loads, heat generation, and resistance to wear, tear, and cracking are also important in the selection of the proper black.

Non-Tire Applications

In non-tire applications, the type of carbon black is selected for end-use of the product, specification requirements, and compounding costs. The entire range of carbon blacks, singly or in blends, may be drawn upon to satisfy the need of a particular compound.

A choice of reinforcing, semi-reinforcing, or thermal types of carbon black is usually selected for use in the following non-tire applications: molded and extruded mechanical goods, wire and cable jackets, shoe soles, heels, oil-well parts, motor mounts, hose, rolls, mats, belting (transmission and conveyor), packings, automotives, V-belts, flooring, gaskets, tubing, tank linings, roll coverings, O-rings, and seals.

Normal Applications of Various Types

SAF (Super Abrasion Furnace) is ideally suited for production of better, longer wearing tire treads, industrial belts, tank tread blocks, and the type of mechanical goods that must withstand severe conditions.

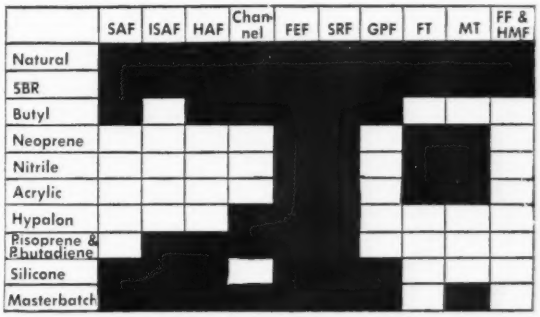


Fig. 2. Types of carbon black normally used in various rubbers

ISAF (Intermediate Super Abrasion Furnace) is well adapted to natural rubber truck tires to improve mileage and increase resistance to tread-cracking. It is also used to good advantage in tire treads based on oil-extended rubber and in tread rubber (camelback) to improve the wear, and in rubber belts and in mechanical goods which are subjected to severe service conditions.

HAF (High Abrasion Furnace), while used mostly in tire treads, is nevertheless valuable in all mechanical rubber goods where abrasion resistance is important. HAF finds extensive application in tire treads, tread rubber, industrial belts, hose, and agricultural rubber products requiring a high degree of toughness and sturdiness.

Channel blacks (EPC: Easy Processing Channel, and MPC: Medium Processing Channel) are used where good reinforcement and high tensile strength are required. These blacks find wide application in natural rubber tire treads, for example in off-the-road tires where resistance to abrasion, cutting, tearing, and low-heat build-up are prerequisites; in tire body plies and in truck tire sidewall stocks; in top ply and breaker stocks; and in combination with other blacks in butyl inner tubes.

FEF (Fast Extrusion Furnace) serves well in a majority of mechanical goods where dimensional accuracy of extrusion and molding is desirable. FEF is particularly suitable when blended with SRF in heavy-duty tire

body stocks where it helps maintain low sidewall temperatures and also imparts strength at elevated temperatures. This black is most satisfactory for use in butyl inner tubes because of desirable resilience plus smooth fast-tubing qualities and reduction in heat build-up. FEF also gives true extrusions, model moldings, high-quality appearance, slick smooth surface, delicate feather edges, suppleness, and pliability.

FF (Fine Furnace) has established itself in compounds for natural rubber breakers, cushions, undertread, and top ply, and wherever additional reinforcement which cannot be obtained with moderate reinforcing type black is desired. There are numerous uses for the FF black in mechanicals.

GPF (General-Purpose Furnace) has extreme versatility of application. It can be used in tire body stocks; breaker, cushion, sidewall, and undertread compounds; in motor mounts for trucks and airplanes and similar service where dynamic stress is an essential factor; in extruded or calendered mechanical goods; footwear; cables; high-speed belting; and conveyor covers.

HMF (High Modulus Furnace) is characterized by low volume cost, smooth processing, balanced modulus, low shrinkage, and good physical properties. It offers high resilience and sufficient resistance to abrasion and flex-cut growth as well as low hysteresis. Its compounds are adapted to motor mounts for trucks and airplanes and similar service where dynamic stress is an essential factor. HMF is recommended for heavy-duty tire treads, butyl inner tubes, extruded or calendered mechanical goods, footwear, cables, high-speed belting, conveyor covers, and for blending with channel black.

SRF (Semi-Reinforcing Furnace) is suitable for many types of mechanical goods, wire insulation, bead wire insulation, automotive, general-purpose molded and extruded goods, in breaker, body ply, cushion, squeegee and gum strips, and in blends with FEF for butyl inner tubes.

FT (Fine Thermal) is an excellent filler for neoprene requiring a 40-80 durometer range; in mechanical molded goods where a good low compression set is essential; in sheeting where it produces a firm, but flexible coating; in mechanical goods, footwear, wire and cable covers; and in oil-resistant stocks.

MT (Medium Thermal) is a low-cost black for use as a filler in low-cost compounds. It finds application in general-purpose as well as high-grade mechanical goods, footwear, wire and cable coverings, oil-resistant stocks, in high-volume rubber stocks, and cross-linked polyethylene, as well as in compounds where high loadings are required.

Conductive blacks (CF: Conductive Furnace, and CC: Conductive Channel) find application in rubber goods where good electrical conductivity is mandatory.

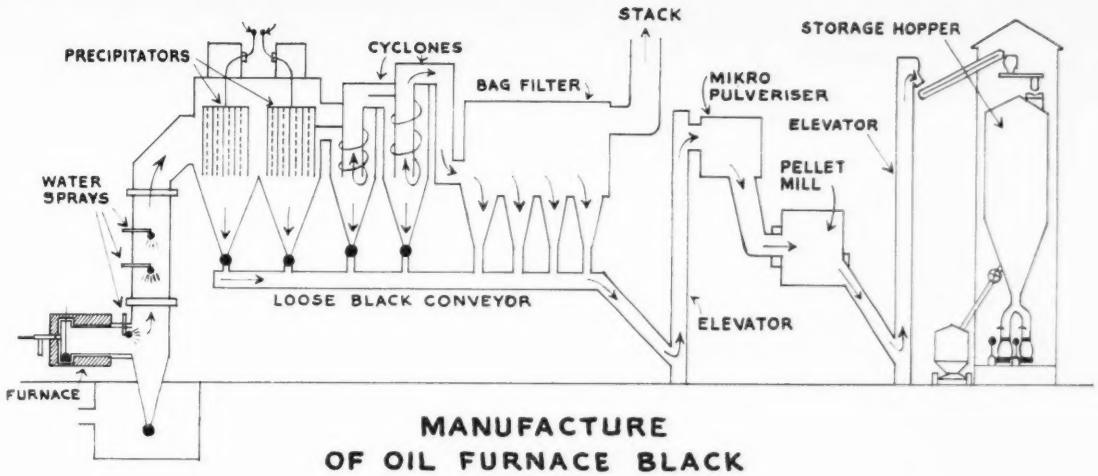
Low structure blacks are, as the name implies, characterized by lower structure, lower modulus, higher elongation, and low hardness. They are admirably suited for tires that must ride quietly and possess good traction properties. Because of the lower modulus, these blacks may be used at increased loadings without unduly increasing the final modulus level.

Factors Determining Choice

Clearly one or more of the types of carbon black can readily fill each need of the rubber industry. The

	SAF	ISAF	HAF	EPC	FEF	FF	HMF	GPF	SRF	Rein. Furn.	Channel
Auto								●	●	●	●
Truck								●	●	●	●
Bicycle								●	●	●	●
Industrial								●	●	●	●
Tread	●	●	●	●							
Carcass			●	●	●	●	●	●	●		
Inner Tube			●	●				●	●		
Camelback	●	●	●		●						

Fig. 3. Types of carbon black which are generally used in the various parts of a tire



MANUFACTURE OF OIL FURNACE BLACK

next problem is what factors govern the choice of a particular black for a particular compound.

The important considerations to keep in mind when deciding on a carbon black are:

1. Costs. These include costs of blacks, other ingredients, as well as the economic aspects of the mixing.
2. Available mixing equipment.
3. The function of the end-product and the service conditions it will be expected to meet.
4. Specification requirements.
5. Type of rubber being used.
6. Compound formulation.
7. Carbon black loading.
8. Whether your original stock is a dry mix or a black masterbatch.
9. Desirable degree of dispersion.

To use carbon black effectively, it must be incorporated intimately in the rubber. Mixing can be accomplished either by laborious dry mixing or, in the case of SBR, by using a black masterbatch in which the carbon black has been intimately dispersed while the rubber was still in the liquid latex state. Fewer pieces of mixing equipment and less mixing are needed to complete the compound when black masterbatch is used.

Once the carbon black is chosen, the particular factors governing its effective use in a dry mix are Banbury rotor speed, ram pressure, batch size, conditioning of mixing equipment, rubber breakdown, order and method of addition of ingredients, mixing time, discharge temperature, working of the discharged stock and its remilling.

It is assumed that the compound involved is one designed for use in heavy service. The carbon black, therefore, should be well dispersed to provide the best rubber physicals. If, on the other hand, the dispersion of the black is not a criterion and compound cost and other economic circumstances dictate maximum throughput at minimum expense, then a different approach to mixing requirements is necessarily used.

Order of Adding Ingredients

The mixing equipment, its conditioning for the job, batch size, and mixing time, and discharge temperature will influence the dispersion of the carbon black. The order of addition of the ingredients is important. For effective dispersion, it is advisable to incorporate the carbon black before the processing oil and while the rubber is still stiff and at a relatively low temperature so as to obtain the maximum shearing action. The oil should be added only after the carbon black has been dispersed. In the case of high loadings of carbon black it is sometimes necessary to wet down the carbon black with some light oil to facilitate mixing it into the rubber. In the case of natural rubber, the dispersion of the carbon black can be further improved by working the stock on the mill or by remilling the cooled stock. Little can be gained, however, from the standpoint of improved dispersion by additional work on SBR, except for the additional softening of the stock.

Mill mixing requires a longer time, and, because of the steps involved to incorporate all the ingredients, the dispersion of the carbon black is more thorough than in the case of a Banbury mix. Here again, the carbon black should be added ahead of the processing oil if good dispersion is essential.

When carbon black is used in a black masterbatch, first consideration goes to costs in general, compound formulation, specification requirements, and operating conditions. Other important factors are rotor speed, ram pressure, batch size, conditioning of mixing equipment, preparation of masterbatch for mixing, further additions of black or oil when required, and cycle time.

While many masterbatches of various compositions are available to the rubber industry, there are still occasions when adjustments must be made in the compound in the mill room, by adding more carbon black, rubber, or oil to achieve a stock with a desired composition. The black masterbatch bales frequently have to be sectioned to make their loadings easier in a smaller-size Banbury or on an open mill. Banbury conditions must be established so as to make effective use of the black masterbatch, and stock temperatures must be suf-

ficiently high to take up any additional oil without undue increase in mixing time. Since the economy of using a black masterbatch hinges on shortening the mixing time and eliminating one or more mixing steps, it is quite important that the stock be sufficiently broken down in the allotted mixing time to enable it to tube satisfactorily, and also that the stock temperature be low enough so that the curatives could be added without incurring scorch.

Typical Banbury Cycles

Below are specific examples of how carbon black is used in factory operations. The first Banbury cycle shows the preparation of a tire tread stock using a single pass mix, in a size 11 Banbury, at 40 rpm.

Minutes	
0	Load black masterbatch; lower ram; full pressure.
½	Raise ram; add chemicals; lower ram; full pressure.
1½	Inject oil.
3	Raise ram; add curatives; lower ram; full pressure.
3½	Raise ram, sweep down; lower ram, float.
4	Raise ram; open slide; dump batch.

The next example illustrates the first pass of a two-pass mix in a tire tread masterbatch, also using a size 11 Banbury, at 40 rpm. The final or second pass where the curatives are added constitutes another mix.

Minutes	
0	Load SBR; lower ram; full pressure.
1	Raise ram; add all black; lower ram; full pressure.
2¾	Inject oil.
4	Raise ram; add chemicals; lower ram; full pressure.
5	Raise ram; open slide; dump batch.

Another example of the preparation of a tire tread masterbatch based on a two-pass mix gives a somewhat different first pass on a size 11 Banbury at 40 rpm. Again the second pass constitutes another mix.

Minutes	
0	Load SBR; add zinc oxide, stearic, antioxidant, black; lower ram; full pressure.
2¼	Inject oil.
4	Raise ram; open slide; dump batch (temperature: 280° F.)

Use of carbon black in a tire tread base masterbatch in a high-speed Banbury is illustrated in the following time schedule. This is also the first pass of a two-pass mix, this time in a size 11 Banbury, at 60 rpm.

Seconds	
0	Load rubber; add zinc oxide, antioxidant, stearic acid.
15	Close door; load 82½ parts black.
45	Lower ram (line pressure, 85 pounds).
82½	Take air off ram; inject oil.
112½	Door still closed; weight still down; oil scale discharged to surge tank.
135	Door still closed; weight down; dump batch, 325-340° F.
150	Move masterbatch to pelletizer.

Following is an example of incorporation of carbon black in a butyl tire tread masterbatch using a size 11 Banbury at 40 rpm.

Minutes	
0	Load butyl; add Elastopar,[1] lower ram; full pressure.
½	Raise ram; add 50 pounds of black over ram; lower ram; full pressure.
2	Raise ram; add 50 pounds of black; lower ram; full pressure.
3½	Raise ram; add zinc oxide and stearic acid; lower ram; full pressure.
5½	Raise ram; add balance of black; add softener; lower ram; full pressure.
7½	Raise ram; open slide; dump batch.

A Banbury cycle for carbon black in a butyl inner-tube masterbatch is described next. Below is the first step of a two-pass mix in a size 11 Banbury at 40 rpm. The second step is not given.

Minutes	
0	Load butyl; add Polyac,[2] zinc oxide, SRF, EPC; lower ram; full pressure.
2	Raise ram; add FEF and oil; lower ram; full pressure.
4	Raise ram; sweep down; lower ram; full pressure.
5	Raise ram; open slide; dump batch.

Preparation of a mechanical extrusion in a size 11 Banbury, at 30 rpm, is shown in the example below. Only the first pass is given.

Minutes[3]	
7	Load SBR; add odd weight of black, wax, whiting, chemicals; lower ram; full pressure.
5½	Raise ram; add balance of black; lower ram; full pressure.
4	Inject oil.
2½	Raise ram; sweep down; lower ram; full pressure.
1½	Raise ram; open slide; dump batch.
0	Close slide; reset clock to seven minutes.

The final example indicates the use of carbon black in a mechanical rubber. It is a single pass, upside-down mix in a size 11 Banbury at 40 rpm.

Minutes	
6	Load chemicals, whiting, oils; add SBR on top; lower ram; full pressure; add black on top of ram.
4	Raise ram; sweep down; lower ram; full pressure.
2½	Raise ram; add curatives; sweep down; lower ram; full pressure.
1	Raise ram; open slide; dump batch.
0	Close slide; reset clock to six minutes.

From a volume usage standpoint, carbon black is second only to the polymer hydrocarbon in rubber compounding. The carbon black industry is keeping pace with developments in the rubber industry and is providing the high quality of black mandatory for newly developed rubbers.

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[1] Monsanto Chemical Co., Akron, O.
[2] E. I. du Pont de Nemours & Co., Inc., elastomer chemicals department, Wilmington, Del.
[3] The variations in style of listing time are an example of the variations occurring in actual practice.

On-the-Spot Report by R. G. Seaman—
Second International Synthetic Rubber Symposium

London Meeting Focuses Attention On Stereospecific Solution Polymers

The Second International Synthetic Rubber Symposium held at Church House, Westminster, London, October 11, 12, and 13, was noteworthy for the way in which it focused attention on recent worldwide advances in solution polymerization of stereospecific synthetic rubbers and plans for their production on a significant commercial scale. The properties and processing techniques of these new rubbers were the subject of other papers on an excellent program which did not neglect meanwhile the latest developments in SBR, butyl, nitrile, and silicone rubbers and the fluorocarbon elastomers. Included also were papers on the exacting demands being made on elastomers for aircraft and missile work, the measurement of tread wear of various synthetic rubbers, and the effect of carbon black structure on synthetic rubbers.

Of special interest was the participation of the Rt. Hon. Viscount Hailsham, England's Minister of Science, as honorary president of the Symposium; Sir Harry Melville, Secretary, Department of Scientific and Industrial Research, as president; and G. E. Beharrell, chairman of the board of both Dunlop Rubber Co., Ltd., and of the International Synthetic Rubber Co., Ltd., as chairman of the Symposium.

Organized for the second time since 1957 by *Rubber and Plastic Age*, the Symposium had a registration of more than 900 persons from many parts of the world and was accompanied by a very fine exhibition by about 100 rubber product, materials, and machinery and equipment companies.

The official symposium dinner was held at the Savoy Hotel on the evening of October 12. Receptions were held by Monsanto Chemicals, Ltd., Dunlop Rubber Co., Ltd., and Shell Chemical Co., Ltd., on other evenings throughout the week.

Rubber and Plastics Age has founded a Gold Medal Award which will be given annually to the person who, in the opinion of an independent panel of judges, has contributed outstanding services to the Synthetic Rubber Industry. The first award will be made in the Autumn of 1961.

Walter A. Lee

Lord Hailsham opening the Second International Synthetic Rubber Symposium on October 11. On the left is A. J. Pickett, *Rubber and Plastics Age* editor, and on the right is G. E. Beharrell, chairman, Dunlop Rubber Co., Ltd., and chairman of the Symposium

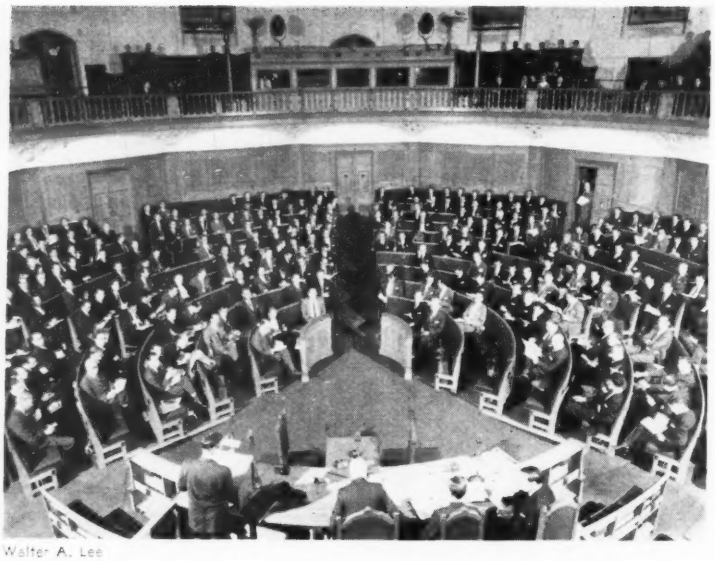
Official Opening

Mr. Beharrell in his remarks at the opening of the Symposium and Exhibition on the morning of October 11 said that it gave him a great deal of pleasure to act as chairman for the meeting. He welcomed Lord Hailsham and then extended a welcome to all present, especially visitors from other countries.

A world consumption of nearly five million tons of natural and synthetic rubbers by 1970 was predicted by Mr. Beharrell. He added that the proportion of synthetic rubber consumed worldwide in 1960 is expected to rise to more than 45% and that part of the explanation for this situation lies in the increased number of synthetic rubber producers. Reference was made to the intensive research being carried out on *cis*-polybutadiene and *cis*-polyisoprene rubbers, which may replace natural rubber in certain applications where low heat buildup is required, such as in large truck tires. This trend could materially raise the proportion of synthetic rubber in total consumption during the next ten years, he declared.

In conclusion, Mr. Beharrell said that the continued expansion in consumption and manufacturing capacity of the specialty rubbers, which have hitherto been more expensive than the general-purpose types, may lead to cost reductions and new achievements in the development of unusual rubbers.

Lord Hailsham, in officially opening the Symposium and Exhibition, joined the chairman in welcoming those present, especially the visitors from abroad. He expressed pride in England's scientific achievements and called attention to the interest not only of industry, but of the government in both natural and synthetic rubbers. Constant develop-



Walter A. Lee

An overall view of one of the sessions of the Symposium

ment of new uses for rubber will be such as to provide a solid economic basis for both types of rubbers for a very long time to come, he added.

Lord Hailsham said he welcomed the holding of the Symposium and felt that it would yield important scientific results. The future alone will show that the developments of combinations between natural and synthetic rubbers, or the development of new types of synthetic rubber, or new uses for natural rubber may very well depend upon meetings of this kind, he continued. There is a great deal of secrecy in the fields of both politics and commerce, but Lord Hailsham said it was his conviction that the need of secrecy can be very much overdone and that the advantages to be obtained from a frank interchange of ideas are very often underestimated. The sharing of ideas not only insures remaining on the alert to acquire the ideas of others, but that one does not try to rest on his laurels by trying to keep such secrets.

In opening the Symposium and Exhibition, Lord Hailsham wished the participants the very greatest of good fortune and success in their discussions.

October 11 Sessions

Sir Harry Melville acted as chairman for the morning session on October 11 and after making some comments on the subjects to be covered in the program introduced the author of the first paper.

"Mechanisms of the Stereospecific Polymerization of Dienes," by Prof. C. E. H. Bawn, University of Liverpool, was the opening paper. Professor Bawn reviewed the notable advances in methods of polymerization of dienes by which the detailed molecular structure of the product may be brought under control. The two main classes of stereospecific catalysts, that is, alkali metals and alkali metal alkyls and Ziegler-type combinations, were shown to be similar in function in that they both are ionic in character and that polymer growth involves stepwise insertion in a metal alkyl chain. *Cis* and *trans* coordination complexes of butadiene with butyl-lithium were discussed, and mention was made of the recent discovery of soluble catalysts for stereospecific polymerization. The mechanism of stereospecific polymerization and the influence of polymerization conditions on the structure of the polymer were explained.

"Effect of Structural Imperfections on Certain Properties of Stereo Rubbers," by K. W. Scott, G. S. Trick, R. H. Mayor, W. Saltman, and R. H. Pierson, Goodyear Tire & Rubber Co., Akron, O., was the next paper. Dr. Scott said that minor amounts of structural imperfections, resulting from different modes of addition, of stereo polymerized diene rubbers have been found to have only negligible effects on viscoelastic properties, but very pronounced effects on properties related to the formation of crystalline regions. The rate of crystallization is extremely sensitive to even minor amounts of structural imperfections, and the tensile strength of rubbers is a typical crystallization dependent property.

Tensile strengths of gum compounds of a number of high *cis*-1,4-polyisoprenes are similar at low degrees of cross-linking; however, the maximum tensile strength as well as the tensile strength at high degrees of cross-linking increases with the rate of crystallization (at —25° C.) of the rubbers in the following order: alkyl-lithium, aluminum trialkyl/titanium tetrachloride, isomerized natural, natural.

In addition to the amount of structural imperfections their disposition is also important. The melting point *vs.* composition behavior of high *cis*-1,4-polybutadienes, prepared in a variety of ways, indicates that for certain catalyst systems the structural imperfections are introduced in a non-random fashion.

The chairman for the afternoon session on October 11 was Mr. Maldwyn Jones, development director, plastics division, Imperial Chemical Industries, Ltd.

"Advances in Anionic Polymerization," by Prof. M. Morton, E. E. Bostick, and R. Livigni, University of Akron, Akron, was the first paper of this session. Professor Morton said that the use of soluble initiators of the alkyl-lithium type has made possible a more detailed study of the kinetics and mechanism of anionic polymerization of mono- and di-olefins. Although these homogeneous systems do not exhibit the degree of stereospecificity shown by the Ziegler-Natta type of catalysts, they are relatively simpler in mechanism in that they show no sign of any termination reaction of polymerizing chains.

Recent work at the University of Akron has shown that the polymerization of styrene, butadiene, and isoprene can, with suitable precautions, be carried out in these systems without interference by chain termination. This leads to polymers having a very narrow distribution of molecular weights, but this distribution is very sensitive to presence of impurities or to other side reactions.

It has also been found that the anionic chain ends are strongly associated, in the absence of any solvating medium, e.g., ethers, tetrahydrofuran, etc. Viscosity measurements on the polymerizing solutions and kinetic data indicate that the association of these macromolecules is generally in pairs, and that such chain-end pairs show a much slower polymerization rate than the "free" carbanions which exist in a solvating medium, e.g., tetrahydrofuran.

This association phenomenon is apparently general for the organometallic system carbon-lithium and was present in all the cases studied, i.e., styrene, butadiene, and isoprene. Hence the unique feature of the stereospecific *cis*-1,4-polymerization of isoprene must be due to the special steric factors involved in the entry of an isoprene unit into the region of associated chain ends.

"The Dynamic-Mechanical Properties of Filler-Loaded Vulcanizates," by A. R. Payne, Research Association of British Rubber Manufacturers, Shawbury, Shrewsbury, Shropshire, was the

next paper on the program. Mr. Payne reported on dynamic mechanical measurements made on butyl rubber containing varying amounts of HAF carbon black. The measured dynamic modulus, G*, decreased with increasing strain amplitude of deformation, and tan. δ (the loss angle) increased from a value approximating to that of a pure gum rubber to a maximum at a critical point. The modulus changes were expressed in terms of G_0, the complex shear modulus at low strains, and G_{00}, the complex shear modulus at very high strains.

The behavior of filler-loaded vulcanizates can be explained by these different mechanisms: (a) effect of weak linkages due to carbon black structure; (b) hydrodynamic effect of the presence of particles of carbon black; (c) additional effective cross-linking due to strong rubber-black linkages. Most of the modulus changes occur at strains below 0.5 and in strain regions to which rubbers are normally subjected in service.

The effect of HAF black was studied in other polymers including SBR, neoprene, *cis*-polybutadiene, and some fluorinated materials and natural rubber.

"New Controlled Structure Polymers of Butadiene," by W. W. Crouch and J. N. Short, Phillips Petroleum Co., Bartlesville, Okla., was the final paper of this session. Dr. Crouch first mentioned that an active area of research in many high polymer laboratories is the use of stereospecific catalysts to prepare polymers of controlled structure. Hundreds of polybutadiene elastomers have been made by Phillips of widely varying *cis, trans,* and vinyl structures, four of which have been selected for plant production or market development.

The product of the greatest commercial interest is *cis*-1,4-polybutadiene of about 95% *cis* content. Owing to its low heat build-up and excellent abrasion resistance, this material has given outstanding performance in tire tread compounds. At least seven companies now have plans to construct full-scale plants for the production of this type of rubber. Polybutadiene of 85 to 90% *trans* content is another interesting polymer for use in hard rubber stocks and is currently being marketed from a semi-commercial plant. Two other butadiene elastomers under market study include a 75/25 butadiene-styrene copolymer and an 80% *cis*-polybutadiene of interest in low-temperature applications.

Another interesting family of polymers includes polybutadienes having chain ends terminated by reactive chemical groups. These "telechelic" polymers react during vulcanization to tie the carboxylic, hydroxyl, or mercaptan chain ends into the vulcanization network.

It is expected that these and many other new "tailor-made" elastomers will be entering commercial production within the next few years as a result of the use of stereospecific catalyst systems.

Walter A. Lee

A closeup of some of the participants in the Symposium, *left to right*, front row, Dr. Harry Barron, Corrosion Ltd., and chairman of the October 13 sessions; Dr. F. P. Baldwin, Esso Research & Engineering Co.; Dr. J. F. Smith, Du Pont; E. L. Borg, Naugatuck Chemical; and Dr. Maurice Morton, University of Akron, all of whom presented papers

October 12 Sessions

Dr. W. F. Watson, director of research, Research Association of British Rubber Manufacturers, was the chairman for the October 12 sessions.

"Polyisoprene Rubber," by F. W. Hannsgen, synthetic rubber division, Shell Chemical Co., Torrance, Calif., was the first paper of the October 12 morning session. Mr. Hannsgen said that a start is being made at the present time with the large commercial-scale production of polyisoprene rubber following a year and a half of intensive product development work.

The significance of the development of processes to make stereospecific elastomers on a commercial scale was explained in terms of the worldwide supply and demand position for natural and synthetic rubbers. The availability of stereoregular polymers will assure ample supplies of raw material for end-uses where previously available synthetic rubbers were technically inadequate, it was said.

Despite the striking similarity analytical data show between synthetic polyisoprene rubber and *Hevea*, certain differences manifest themselves in processing and handling characteristics, as well as in the final product properties. The narrow molecular weight distribution, for example, creates what is termed "anomalous Mooney behavior" necessitating small, but important changes in compounding techniques.

The versatility of synthetic polyisoprene rubber in a multitude of applications was explained by means of its gum and loaded physical properties, and a brief summary made of the successful utilization of this polymer by the consuming industry.

Mr. Hannsgen said that by the end of 1962 production capacity for 200,000 tons of stereoregular polybutadiene and polyisoprene will be available in the United States and about 100,000 tons' capacity in Europe.

It was stated that development quantities of synthetic polyisoprene latex of about 62% total solids are now available.

"Rheological Properties of *Cis*-Polybutadiene and Other Polymers," by D. Bulgin, Dunlop Research Center, Birmingham, England, was the next paper on the program. Mr. Bulgin explained that *cis*-polybutadiene in the uncompounded state exhibits a sharp change in properties on the mill at a critical temperature in the region of 40° C. Below this temperature the material mills satisfactorily, but above it the material sags and crumbles so that there is only a narrow temperature range for satisfactory milling.

The results of an extensive investigation into the cause of this change in properties, involving measurement of the stress and elongation conditions of the material on the mill rolls, tensile tests on the unvulcanized material, and flow and recovery experiments on laboratory instruments, were reported.

As a tentative explanation of the above-mentioned phenomena it was stated that under the stress and temperature conditions in the nip of the mill, molecular alinement takes place, leading to formation of crystallites which "melt" above the critical temperature. This explanation is consistent with G. Natta's views on polymorphism in linear polymers.

The effect of this phenomena on extrusion experiments using laboratory instruments was discussed also.

"Polybutadiene Rubber," by E. F. Engel, Chemische Werke Huls AG, Marl, West Germany, was a continuation of the discussion on this rubber based on a paper given before the German Rubber Society in West Berlin on October 5. Dr. Engel showed how polymerization conditions were related to the *cis*-1,4-content of polybutadiene. He presented data on the processing of 50/50 blends of natural rubber and polybutadiene which indicated that

such blends handle as well as natural rubber alone.

Dr. Engel stated that polybutadiene-carbon black masterbatches were being prepared by mixing the black into the polymer solution, and he said also that oil-extended polybutadiene rubber had been prepared containing 30% of a highly aromatic oil.

The results of mass polymerization in a continuous operating polymerization extruder were discussed, and although this process is still in the development stage, it has a potentially high rate of synthetic rubber production.

"Physical and Technological Properties of *Cis*-Polybutadiene," by G. Natta and S. Leghissa, Istituto di Chimica Industriale del Politecnico, Milan, Italy, was given by Dr. Leghissa since Dr. Natta was unable to attend the Symposium because of ill health.

During the last few years all the four foreseen types of stereoisomeric polybutadienes, each containing practically only one kind of monomeric unit characterized by its type of enchainment and steric structure, have been obtained at high steric purity, using different stereospecific catalysts.

The properties and characteristics of a 97 to 98% *cis*-1,4-polybutadiene, the synthesis of which could be easily realized on a commercial scale, were described. The polybutadiene was obtained with a homogeneous catalytic system and showed such structural properties (purity, steric homogeneity, crystallinity, melting range, very low dispersion of molecular weights, etc.) that it marked a sharp differentiation with regard to the other polybutadienes described up to now.

Some data on the processing of this polybutadiene and its use in compounds with and without carbon black were presented. It would appear to have good workability without blending with natural rubber, and the physical properties of its vulcanizates seemed satisfactory.

"Tread Wear Indices of Various Synthetic Elastomers Measured in Varying Severity Road Tests," by R. G. Bauman, R. L. Marlow, R. F. Miller, and J. L. Ginn, The B. F. Goodrich Co., Akron, was the first paper on the program for the October 12 afternoon session. Dr. Bauman pointed out that the very wide diversity of the wear properties of the newer synthetic rubbers requires the development of improved tire tread wear tests. Tires have been tested under constant severity conditions which provide rates of wear varying by a factor of 1,000. The lowest severity of wear employed for these tests was obtained in straight ahead driving at a constant 40 mph., and the highest severity by cornering continuously at a centripetal acceleration of 12 ft./sec.^{2}

The relative tread wear of two compounds is affected not only by the average severity of a given road test, but also very markedly by the particular combination of severities encountered as the car accelerates, decelerates, corners, or travels at constant speed. Because of the combination severity effect, two road tests may result in widely different wear on test tires of identical construction, even though the control tires show the same loss.

Cis - polybutadiene - natural rubber blends show remarkable abrasion resistance, particularly under conditions of moderate and high abrasive severity. SBR is also known to provide some improvement over natural rubber in the same range of severity. On the other hand, natural rubber shows relatively less wear at very low severity. Consequently, in order to provide an adequate evaluation of a new rubber, the wear tests must combine a carefully controlled range of severities which are related to their ultimate application. Only from information obtained in this manner can new polymers be used in tire treads to the best advantage.

"Carbon Black Structure Effects in Synthetic Rubber," by E. M. Dannenberg, T. D. Bolt, R. E. Dobbin, and R. P. Rossman, Cabot Corp., Boston, Mass., was the next paper. Mr. Dannenberg said the objectives of the study reported in this paper were to estimate the relative degree of primary structure characteristics of carbon blacks and to determine the effect of changes in this property on rubber performance. Relative differences in primary structure influence oil absorption and dry compression void volume measurements and in unvulcanized rubber mixes, influence extrusion die swell and plasticity.

The stress-strain behavior of vulcanized compounds can be drastically altered by structure changes in the carbon black used, and some data were presented for the modulus at 300% elongation for an experimental super structure black, ISAF black of high structure, a new normal structure furnace black, and an experimental black of low structure, to demonstrate this point.

Extreme lowering of structure results in difficult dispersion behavior which can be partially overcome by special mixing techniques. Whereas moderate structure lowering from the levels of presently used blacks is desirable for certain applications, the extent to which this can be done is limited by dispersion difficulties and loss of reinforcing ability.

"Relationship of Intrinsic Viscosity to the Intrinsic Vistex Viscosity and Plasticity of Cold Styrene-Butadiene Rubber," by E. W. Duck and J. A. Waterman, Koninkliijke/Shell Laboratorium.

Dr. Duck explained that the primary evaluation of unvulcanized SBR samples involves the determination of the intrinsic viscosity (IV) of the soluble fraction of the dry rubber, or the related intrinsic vistex viscosity of the latex, and determination of the percentage of gel present. [Vistex viscosity is determined by mixing the latex with two solvents, one of which dissolves the polymer particles, and the other mixes with the aqueous phase.—Editor.] A good correlation was found between intrinsic and vistex viscosities, namely: intrinsic vistex M 0.75 (IV).

Another useful characteristic is the Hoekstra compression plasticity, which can be determined on very small samples of rubber (about one gram). A linear relationship between the inherent viscosity (taken instead of the intrinsic viscosity in this part of the work) and the Hoekstra plasticity was found for cold SBRs of low gel content: Inherent viscosity (M IV) = 0.0326 (Hoekstra) +0.808. This relationship appears independent of conversion over a large range (27 to 93%), and at the normal conversions of 60 to 65% it is also independent of the degree of modification and of the emulsifier which was employed.

Comparative measurements of Hoekstra plasticity and Mooney viscosity, which latter determination requires larger samples, were presented for SBR 1500 type rubbers prepared to conversions in the range of 60 to 65%.

(To be continued)

Ontario Group Told Of Work on Nitriles

Uses of modern cold nitrile rubbers and cross-linked NBR rubbers were outlined November 8 at the annual joint meeting of the Ontario Rubber Group and the Wellington-Waterloo Section of the Chemical Institute of Canada at the Kress Hotel, Preston, Ont., Canada. More than 120 members and guests were present.

H. A. Pfisterer, of Polymer Corp., Ltd., co-author of a review paper on the subject, explained that cold nitrile rubbers are easier to process than hot nitriles, and that cross-linked nitrile rubbers are processing aids which improve even cold nitrile rubbers. In most cases 25 phr. of cross-linked NBR are used to replace an equivalent amount of regular NBR with no other change in the recipe, he said.

The speaker also discussed development of compounds which can be used in dry heat at temperatures up to 250° F. and in unmodified petroleum oils at temperatures in excess of 300° F. He also considered blends of NBR with PVC and investigations on improvement of the color of raw polymers and their end-products.

Elastomer Developments Discussed At Sixth Military Joint Conference

A conference which brought together the leaders of industry, government, academic, and military fields to discuss the latest in research and development on the elastomeric requirements for global military operations and new weapons systems was held in Boston, Mass., in October.

The conference, the sixth since 1950, was sponsored by the U.S. Army Quartermaster Research & Engineering Command and conducted by the Committee on Elastomers, National Research Council Advisory Board on Quartermaster Research and Development, under an agreement where the three services alternate in sponsoring these Joint Army-Navy-Air Force Conferences on Elastomer Research and Development at two-year intervals.

The Hotel Statler-Hilton was the scene of the meeting held on October 18-20 with J. C. Montermoso, QMR&E Command, the general chairman. Others on the committee included J. H. Faull, Jr., U.S. Navy; J. M. Kelble, U.S. Air Force; W. George Parks, NRC Advisory Board; and R. F. Dunbrook, NRC Advisory Board.

More than 230 people accepted the invitation to attend extended by the committee and heard the résumés of about 45 papers. Owing to the large number of presentations without resorting to concurrent sessions, time did not permit the reading of each full paper. The complete works will be included in the Proceedings of the meeting which will be made available to attendees as soon as it can be printed.

Subjects included in the talks ranged from basic polymer research, through special applications, and into new elastomer development.

Among the special features of the conference were included some round-ups on elastomer research abroad, a banquet, and a visit to the Natick, Mass., laboratory of the QMR&E Command.

The summaries of European work were featured along with the opening remarks in the initial session of the meeting and included United Kingdom developments, by H. Warburton Hall, Ministry of Aviation, United Kingdom; British Admiralty organization and status of elastomer research by G. N. S. Farrand, Admiralty Materials Laboratory; and by J. H. Faull, Jr., of the United States Office of Naval Research, who spent several months in Europe in the spring and reported on some highlights of polymer research there.

The banquet, held Wednesday evening, was preceded by a social hour and featured a talk by Lt. General Arthur G. Trudeau, Chief, Research & Development, Department of the Army. General Trudeau was unable to attend, however, so that Richard A. Weiss, deputy and scientific director, Army Research Office, delivered the talk for him. Some very interesting pictures were shown along with the presentation covering many novel and glamorous as well as work-a-day applications of elastomers in Army equipment.

Titles of the reports are listed below as they appeared in the official program of the meeting even though there were some changes necessary during the presentations owing to time or author availability.

Dr. J. C. Montermoso, QMR&E Command, General Chairman

Session 1

Opening Remarks

Dr. G. R. Thomas, QMR&E Command

Introduction

Brig. General Merrill L. Tribe, QMR&E Command

Welcome Address

Major General Roy T. Evans, Jr., Deputy The Quartermaster General

The Hole in the Fabric of Research. J. R. Townsend, Special Assistant to Director of Defense, Research & Engineering.

Support of Basic Research on High Polymers by the National Science Foundation. A. Kotch, Assistant Director, National Science Foundation.

Some U. K. Developments in the Elastomer Field. H. Warburton Hall and W. H. Edwards, Ministry of Aviation, United Kingdom.

The Organization and Status of Elastomer Research in the British Admiralty. G. N. S. Farrand, Admiralty Materials Laboratory, United Kingdom.

Highlights of European Polymer Research. J. H. Faull, Jr., ONR.

Session 2—Basic Polymer Research

J. M. Kelble, Wright Air Development Division, Chairman

Chain Entanglements and Mechanical Properties of Amorphous Polymeric Systems. T. G. Fox, Mellon Institute.

Chain Dimensions of Polymeric Chains. C. A. J. Hoeve, Mellon Institute.

Role of Entanglements in Degradation of Elastic Networks. K. W. Scott, V. R. Allen, and M. Morton, University of Akron.

Polymer Structure and Its Resistance to a Chemical Agent. K. C. Tsou and B. D. Halpern, Borden Chemical Co.

Antioxidant Action in Polymers. F. H. Winslow, W. L. Hawkins, M. A. C. Worthington, Bell Laboratories, Inc.

Zone Refining Fractionation of Polymers. J. D. Loconti, QMR&E Command, and J. W. Cahill, Lord Mfg. Co.

Mechanism of Amine Cross-linking of Fluoroelastomers. K. L. Paciorek, Wyandotte Chemical Corp.

Aromatic Fluorocarbons: Thermal Stability and Synthesis. L. Wall, National Bureau of Standards.

Polyaromatics. J. E. Mulvaney, H. Vogel, T. Otsu, C. B. Abshire, M. Hasegawa, C. S. Marvel, University of Illinois.

Synthesis of Organo-Lead Polymers Related in Molecular Structure to Silicone Elastomers. A. D. Delman, B. B. Simms, E. Klein, J. Mironov, New York Naval Shipyard.

Silicon-Nitrogen Polymers and Their Coordination. E. G. Rochow, Harvard University.

Inorganic Polymers Containing Coordinated Species. B. P. Block and G. Barth-Wehrenalp, Pennsalt Chemicals Corp.

U.S. Army Photograph

Committeemen and special guests at the Sixth Annual Joint Army-Navy-Air Force Elastomer Conference included *(left to right):* H. L. Nash, Canada; G. N. S. Farrand, United Kingdom; J. C. Montermoso, general chairman, Army; J. M. Kelble, co-chairman, Air Force; J. H. Faull, Jr., co-chairman, Navy; and H. Warburton Hall, United Kingdom

U.S. Army Photograph

Hosts and speakers at the banquet of the Elastomers Conference are shown *(left to right)*: Brig. Gen. Merrill L. Tribe, commanding general, QMR&E Command; J. C. Montermoso; Richard A. Weiss, speaker; Georger R. Thomas, QMR&E Command; and Dale H. Sieling, master of ceremonies, QMR&E Command

Thermally Stable Metallic Salts of Polyvinylphthalic Acid. E. C. Winslow and A. Laferriere, University of Rhode Island.

Poly (Triorganometalloxy) and Poly (Chelated) Metalloxane Polymers. J. B. Rust, C. L. Segal, H. H. Takimoto, Hughes Aircraft Co.

Polymer Program at **WADD.** W. Gibbs, Wright-Air Development Division.

Session 3—Special Applications

Dr. J. H. Faull, Jr., Office of Naval Research, Chairman

Effect on Elastomers of Exposure at Temperatures up to 1000° F. L. J. Kitchen, G. L. Hall, J. D. Rigby, Firestone Tire & Rubber Co.

Sealants for Advanced Flight Systems. P. House, Wright Air Development Division.

A High-Temperature Protective System for Cross-Linked Polyethylene. C. Carr and R. Miller, United States Rubber Co.

New Monomers for Potential Radiation-Resistant Polymers. W. L. Beears and R. J. Fawcett, B. F. Goodrich Co.

Effect of Amine Additives on Compression Set, Cross-Linking, and Chain Scission in an Irradiated Rubber Vulcanizate. W. E. Shelberg, J. F. Pestaner, L. H. Gevantman, Naval Radiological Defense Laboratories.

Mechanism of Ionizing Radiation Damage of SBR Elastomers. A. D. Delman, I. J. Stanley, B. B. Simms, A. E. Ruff, E. Goldberg, New York Naval Shipyard.

Elastomers for Cryogenic Sealing. F. W. Tipton, G. E. Trepus, R. S. Roper, Boeing Airplane Co., and D. H. Weitzel and R. F. Robbins, Cryogenic Engineering Laboratory, NBS.

Polymer Compatibility in Rocket Fuels and Oxidizers. J. Green and N. Levine, Reaction Motors Division, Thiokol Chemical Corp.

Rheological and Spray Properties of Dilute Polymer Solutions. L. Cohen and G. W. Rodon, Army Chemical Center.

Rubber Materials for Damping Vibration of Metal Structures. R. E. Morris, Mare Island Naval Shipyard.

Visco-Elastic Damping Materials. D. H. Kallas, New York Naval Shipyard.

Composite Seal Materials. M. Sabanas and F. Iwatsuki, Armour Research Institute.

Transient Properties of Three Castable Polyurethane Compounds. W. B. Lew and W. Sargeant, Puget Sound Naval Shipyard.

Foamed Resilient Materials and Rubberized Hair for Package Cushioning Applications. S. A. Eller, A. A. Stein, and C. K. Chatten, New York Naval Shipyard.

Polaris Stowage and Launching Adapters. R. E. Morris, Mare Island Naval Shipyard.

Compounding for Protective Masks. H. H. Anderson, General Tire & Rubber Co.

Vulcanizable Saturated Elastomers in Medical Application. F. Leonard, Army Prosthetics Research Laboratory.

Session 4—New Elastomers

Dr. R. F. Dunbrook, NRC Advisory Board on QMR&D, Chairman

Low-Temperature Polyester Elastomers. A. W. Sloan, Atlantic Research Corp.

Evaluation of Cyanopropylsilicone Elastomers. D. B. Braun and E. W. Bennett, Union Carbide Corp.

Synthesis of Arylene-Modified Siloxanes. G. M. Omietanski and W. G. Reid, Union Carbide Corp.

Heat and Radiation Resistant Arylene-Modified Siloxanes. Z. Ossefort, Rock Island Arsenal.

Elastomer Research at WADD. W. Griffin, Wright Air Development Division.

The Synthesis of Fluorine-Containing Monomers. P. Tarrant, University of Florida.

Synthesis of Fluorinated Nitroso Monomers. A. P. Stefani, J. R. Lacher, and J. D. Park, University of Colorado.

Nitroso-Fluorocarbon Elastomers. G. H. Crawford and D. E. Rice, Minnesota Mining & Mfg. Co., and J. C. Montermoso, QMR&E Command.

Properties of Vulcanized Nitroso Rubber. J. C. Montermoso, C. B. Griffis, and Angus Wilson, QMR&E Command.

Light Employed As Rubber Research Tool

Rodney D. Andrews, member of the plastics laboratory of Massachusetts Institute of Technology, explained uses of birefringence to study stress patterns of rubber and plastics in a talk, November 15, before the Elastomer & Plastics Group, Northeastern Section, American Chemical Society. Fifty members and guests were present at the meeting at Science Park, Boston, Mass.

Dr. Andrews explained that birefringence is a measure of directional variation in the refractive index, and that the ratio of stress to birefringence varies with the material. Green light was passed through transparent samples of plastics and elastomers, and the angle of displacement of the light measured. Degrees of stress were varied for each sample. These data were interpreted in terms of molecular group movements within the samples.

The speaker further noted that the effect was used to calculate the length of the statistical chain segment of polymers and to measure monomer sequence in the copolymer chain. Changes in birefringence, he said, would indicate the freedom of the groups to rotate and therefore indicate the difference between syndiotactic forms of polymers, with least degrees of freedom to rotate, and isotactic forms with the most freedom. Effects of water and some plasticizers on birefringence were shown.

Analysis of patterns of birefringence could be used to tailor polymer structure, Dr. Andrews stated.

The Group will hold its next meeting on January 17. A talk will be given on polycarbonates.

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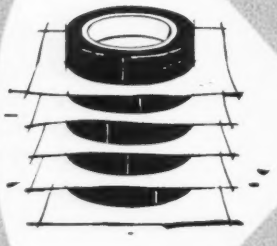

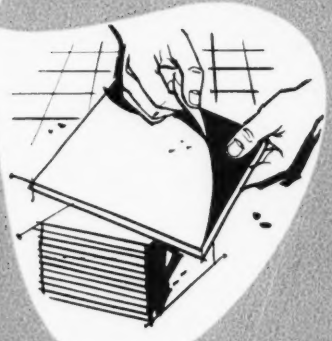

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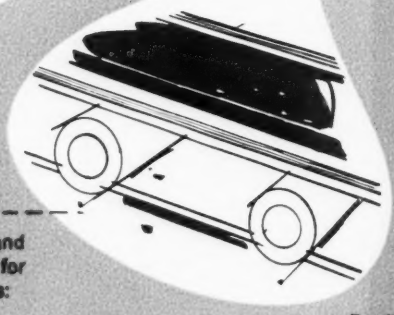

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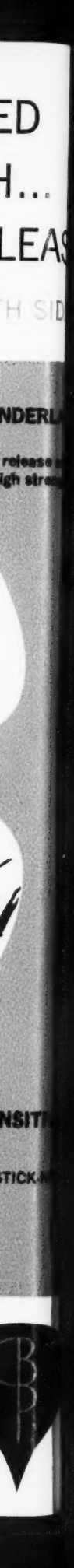

Ridley Placed in AU Hall of Fame; Special Program Features the Event

Henry Nicholas Ridley (1855-1956), English botanist, geologist, explorer, author, and editor, was installed as the seventh member of the University of Akron's International Rubber Science Hall of Fame at the third annual Rubber Science Hall of Fame banquet on the University campus on November 18. A symposium on "Advances in the Knowledge of Natural Rubber" was held on the afternoon of November 18. Both of these events were co-sponsored by the Akron Rubber Group, Inc.

The International Rubber Science Hall of Fame was established by the University in 1958, at which time five individuals who made memorable contributions to the science of rubber chemistry were installed.[1] A sixth member was added in 1959.[2] Pictures of all seven of these men are prominently displayed in the Rubber Science Hall of Fame located in the Science and Technology Division of the Library of the University.

Ridley, who served as director of the Straits Settlements Gardens and Forests in Singapore from 1888 until 1911, brought the first rubber seeds to Malaya and was responsible for the "herringbone" continuous tapping method which made possible the production of natural rubber in large quantities.

Ridley's selection was made by a committee headed by Maurice Morton, Akron University's professor of polymer chemistry and director of the Institute of Rubber Research. Other members of the committee were Thomas Sumner, acting dean of the Buchtel College of Liberal Arts, Columbia-Southern professor of chemistry, and head of the department; G. Stafford Whitby, professor emeritus of rubber chemistry and consultant, Institute of Rubber Research; and A. E. Juve B. F. Goodrich Co., and Ralph Wolf Natural Rubber Bureau, both representing the Division of Rubber Chemistry of the American Chemical Society.

The Symposium Program

The symposium on "Advances in the Knowledge of Natural Rubber" began with a few brief words of welcome to those present by Dr. Morton, who then turned the program over to Dr. Whitby as moderator.

Dr. Whitby introduced the first speaker, K. G. McIndoe, former director of research for Firestone Plantations Co., now acting as research adviser, and described some of Dr. McIndoe's work with rubber and other crops in Liberia and Haiti. Dr. Whitby also mentioned some of his own original work in Malaya in 1913 in measuring the variation in yield from rubber trees and exhibited samples of rubber from this work.

"Advances in Breeding *Hevea* Brasiliensis" were discussed by Dr. McIndoe, who emphasized the spectacular improvement in breeding during the past 35 years that had increased the yield per acre of rubber trees from 500 to 2,000 pounds a year. The possibility of a yield of 3,000 pounds an acre in the future is not unlikely, he said.

Much of the early work done by Dutch and British selectionists in the former Dutch East Indies and Malaya was with descendants from the relatively few seedlings established in the Far East as a result of Wickham's famous transfer of seeds of *Hevea* from Brazil in 1876. The varieties of "clones" produced by these early breeders still form a large part of the considerable areas now giving high yields, and Dr. McIndoe said it was remarkable that such results should have been obtained from so few original trees.

Characteristics other than high yield are also required of the plantation rubber tree, of which may be mentioned vigor, disease and wind resistance, and favorable latex quality. Dr. McIndoe paid tribute to the work of the Rubber Investigations group of the United States Department of Agriculture between 1942 and 1954, which gave stimulus to breeding as a result of exploration of the Amazon valley. Much new genetic material was discovered and incorporated into a breeding program not only in the former Ford plantations in Brazil, but also at other stations in a number of tropical American countries. This work was especially important since it laid the basis for breeding *Hevea* varieties resistant to South American leaf blight, a tree disease which has worked against the successful establishment of plantations in tropical America, it was said.

Modern plantations are generally planted with so-called "budded" varieties, in which the root or "stock" consists of a seedling on which is budded the upper part of "scion." While much attention has been given to the scion, which produces the latex, little has been accorded the root or stock. One of the major difficulties has been the fact that *Hevea* is very difficult to root from cuttings, but in the recent past at the Firestone plantations and elsewhere, important advances have been made in overcoming this difficulty, and it is quite possible that an entirely new field of improvement has opened up, Dr. McIndoe declared.

Another improvement desired by rubber plant breeders is a fast method of sorting rubber seeds into high yielders and low yielders, this speaker said in conclusion.

"Advances in the Chemical Knowledge of Natural Rubber" were described by W. G. Wren, head of the chemical division, Rubber Research In-

Tobias Studio

Dr. Whitby, *right*, exhibiting rubber samples to W. G. Wren, *left*, and K. G. McIndoe, *center*

[1] RUBBER WORLD, Nov. 1958, p. 238.
[2] *Ibid.*, Jan. 1960, p. 532.

stitute of Malaya. In introducing Mr. Wren, Dr. Whitby mentioned Wren's early interest in the application of rubber to highways which led him into civil engineering as well as chemistry. Mr. Wren has been working in the field of natural rubber since 1935 and joined the RRIM in 1950, first as head of the rubber testing and technology laboratories and then as head of the chemical division in 1952.

Phase contrast microscopy has revealed hitherto unsuspected complexities in the disperse phase of latex from *Hevea*, Mr. Wren stated. Recent work has resulted in the separation of fresh latex into 11 different zones by high-speed centrifuging. Miscroscopic examination of these zones has revealed them to be somewhat heterogeneous, each composed of a variety of particles, although one type may predominate. The rubber particles are present in the upper zones, the non-rubber lutoids in the bottom zones, the yellow Frey-Wyssling particles in several zones, and three new types of grey spherical particles have been found associated with the Frey-Wyssling particles.

Long fine threads found in most fractions, but most prevalent in the serum fraction, have been observed and may be of fundamental importance, since pear-shaped rubber particles, Frey-Wyssling particles, lutoids, and innumerable much smaller particles attached to a tangle of these threads may be part of a cytoplasmic structure in latex cells carried away with the flow of latex when the tree is tapped, Mr. Wren explained.

The complex nature of *Hevea* latex is further complicated by bacterial transformations of its constituents which proceed during tapping and collection; some bacteria have now been shown to exist within the latex vessels in regular tapping. New methods of controlling bacterial contamination are being studied and have been found to give increased yields of a latex which has a lower content of bacteria. Many new systems for preserving latex concentrate against bacterial attack have been worked out, although not yet developed to the stage of commercial production.

A recent investigation of the drying of plantation rubber has shown that optimum conditions require high temperature and low humidity. Such conditions give rise to blisters in the finished product, but these blisters can be eliminated by suitable planning of the drying procedure. On this basis more economical drying houses are being designed and developed in Malaya, Mr. Wren said.

Changes in the rubber hydrocarbon have been shown to be responsible for the hardening that takes place during shipment. Means of inhibiting this hardening by the use of amines have been devised, and preliminary shipments of small amounts of rubbers treated with amines to avoid changes in plasticity have been successful. More work is required, however, before establishing that the process is suitable for commercial application.

Henry Nicholas Ridley

Superior Processing rubbers made by incorporating vulcanized latex particles into unvulcanized latex and coprecipitating are finding increased acceptance. A number of other materials such as wood flour, polyvinyl alcohol, casein, and gelatin have been mixed with rubber latex and after coprecipitation have been found to give excellent SP characteristics to the resultant rubber. These materials are being studied further with the hope that less costly SP rubbers can be produced in this way.

Recent work with graft polymers made with natural rubber has shown that the shorter and more numerous the side chains, the harder and tougher is the product, which offers advantages for commercial application.

Other important advances in natural rubber research discussed by Mr. Wren included *cis-trans* isomerism by which crystallization resistant rubbers have been made, and the biosynthetic pathway by which rubber is produced in the tree. Although it is still a moot point whether a better understanding of the biosynthesis of rubber will enable natural rubber producers to modify and control the characteristics of the rubber molecule synthesized by the tree, it might make possible yields even higher than the present maximum, Mr. Wren, said in conclusion.

Hall of Fame Banquet

The third annual Rubber Science Hall of Fame banquet and installation ceremony for Henry Nicholas Ridley was held in the University's Student Center. A highlight of this affair was an address by His Excellency Dato Nik Ahmed Kamil, Malaya's Ambassador to the United States and Permanent Malayan Representative to the United Nations.

Milton Leonard, Columbian Carbon Co., chairman of the education committee of the Akron Rubber Group, presided and first introduced President Norman P. Auburn of the University of Akron, who extended a welcome to those present. Dr. Auburn mentioned that the University started teaching rubber chemistry 53 years ago. He explained that the Rubber Science Hall of Fame will be moved to the new University Library which will be dedicated in April, 1961. He expressed his appreciation to the University of Akron for its cosponsorship of the Hall of Fame activities and then extended a special welcome to Ambassador Kamil.

Brief remarks were made by Harry Van Berg, law director of the City of Akron, representing Mayor Leo Berg, who was unable to be present; I. J. Sjothun, Firestone Tire & Rubber Co., chairman of the Akron Rubber Group; Dr. Morton for the Institute of Rubber Research; and Dr. Sumner for the University's chemistry department.

Dr. Morton conducted the ceremonies in connection with the installation of Henry Nicholas Ridley into the Rubber Science Hall of Fame. The citation was made by Dr. Whitby and read as follows:

"Henry Nicholas Ridley (1855-1956), botanist, who was the director of Gardens and Forests, Straits Settlements, 1888-1911; who developed effective procedures for extracting latex from *Hevea* trees, who thus and in other ways contributed more than any other single man to the establishment of the rubber growing industry, and hence contributed to the rapid development in the early years of this century of rubber manufacturing and the automobile."

Dr. Whitby in further remarks said that but for Ridley the history of Akron would hardly have been what it has. The rapid growth of Akron in the decade 1910-1920 came from an increase in rubber manufacturing, and the supplies of raw rubber needed for this increase would hardly have been forthcoming but for the activities of H. N. Ridley from 1889 onward in encouraging the establishment of rubber plantations in the Far East and in laying the foundations on which were based techniques for extracting rubber economically from rubber trees without damaging them.

Dr. Whitby reviewed the develoment of the plantations industry in Malaya in the early 1900's and gave some details of Ridley's work on tapping techniques which provided the excision principle of tapping. This method resulted not only in a good flow of latex, but permitted the bark to renew itself so that in due course tapping could be resumed on the same area of the trunk of the tree. The development of panel tapping schemes adapted to regular

Speaker's table at Hall of Fame banquet

plantation operation was then largely taken over by the planters themselves in Malaya.

The excision and herringbone method of tapping replaced the incision method used to obtain rubber from the wild *Hevea* trees of the Amazon basin and in the early experimental work in Ceylon. With the incision method, numerous cuts were made with a small hatchet, and new cuts were made on succeeding tappings. The surface of the trunk becomes increasingly rough and knurled as a result of damage to the cambium of the tree when the incision method is used.

Dr. Whitby reported that Ridley also contributed significantly to the development of ways of preparing rubber for the market in that he prepared the rubber in the form of thin sheets that could be readily dried and that he made rubber in the form of rectangular sheets, still today a popular form.

The introduction of Ambassador Kamil was made by Dr. Auburn, who reviewed the career of this distinguished visitor in the government of the Federation of Malaya where he occupied many important posts.

Ambassador Kamil in his address on "Some Aspects of the Economy of the Federation of Malaya" first expressed his appreciation in being able to share in the tribute to Henry Nicholas Ridley, whose work had contributed substantially to the economy of Malaya and helped make possible its economic and political standing as it is today.

Malaya's prosperity is closely bound up with the production for export of two commodities, rubber and tin, but attempts are being made to broaden the basis of the country's economy by intensification and diversification of agricultural products on one hand and the development of secondary industries on the other, the Ambassador revealed. Natural rubber is expected to be the country's chief export commodity in the foreseeable future, however, since it provides directly or indirectly for the main livelihood of at least one-quarter of the population of 7,000,000 people; 60% of Malaya's export income is derived from the shipment of rubber, and 25% of the country's customs and income tax revenue comes from the rubber industry.

Malaya's efforts to improve its competitive position for natural rubber include an expenditure of an equivalent of $4 million (U.S.) on research and development, a replanting program which has been accomplished for 42% of the 3½-million acres in rubber and should be completed in another 10 to 15 years, and the establishment of the Malayan Rubber Export Registration Board to regularize quality and packing procedures, this speaker further declared.

Overall industrial development in Malaya is based on creating the necessary favorable and stable conditions under which private enterprise (both local and foreign) can be induced to establish industries in the country and to flourish. Provisions have been made for the basic requirements of transport and communication, power and electricity, drainage and water supply, training and research establishments, and those other services essential for the effective development of industries, the Ambassador declared. The assistance of overseas capital is warmly welcomed, particularly in fields where technical knowledge and skills are presently lacking, and the policy is aimed to creating a favorable climate for foreign investment especially in combination with local capital.

Efforts of the Malayan Government to promote industrial and economic development are bearing fruit, as evidenced by the registration of nearly 1,000 new companies with a capitalization of $1,237 million (Malayan) during the 1956 through 1959 period. The Ambassador said in conclusion that his country was proud to think that it could offer the potential investor expanding markets and unrivaled opportunities in that part of the world.

The banquet program was concluded by the presentation of plaques in commemoration of the event to Ambassador Kamil and to Dr. McIndoe and Mr. Wren by Mr. Leonard.

Jane Memorial Lecture

E. Ralph Rowzee, president and managing director, Polymer Corp., Ltd., Sarnia, Ont., Canada, noted the progress made in the Canadian synthetic rubber industry in the last 20 years and made some suggestions for further improvement, in his speech, "Rubber, Research, and Human Resources," given in connection with the R. S. Jane Memorial Lecture Award. He spoke before the Canadian Chemical Engineering Conference of The Chemical Institute of Canada, November 9, in Quebec, P.Q.

Dr. Rowzee pointed out that the design of the standard plant has required relatively few changes in almost 20 years. Process changes and changes in auxiliary equipment, however, have been made to a larger extent, thereby increasing capacity and quality. During the last 15 years Polymer Corp.'s production went from 50,000 to 150,000 tons a year, using essentially the same equipment. In addition, post-war markets have brought 65 to 70% of Polymer's output to 60 other countries.

Further improvements could be made in using Canada's human resources, Dr. Rowzee added. Too many university graduates have received inadequate technical training to fill industry's engineering or chemical requirements. The present generalized training has the production of managers as its objective. Managers could better be produced within industry or at the graduate level.

He commended the present trend to pay qualified top-flight technical employees salaries closer to those paid to supervisors. This, he said, brings into a more appropriate balance the role of the scientist. It is a misuse of training to use chemists and chemical engineers as technicians, Dr. Rowzee added.

In conclusion he stressed the need of continued industrial research to improve Canada's patent position in the world, to develop new equipment and techniques, to increase Canadian secondary and consumer goods manufacturing, and to encourage young people with ability to remain in Canada.

More on 1960 Berlin Congress Of the German Rubber Society

The initial report of the meeting of the German Rubber Society, which was held in West Berlin, October 4-8, was presented in our November issue, beginning on page 90. In that report we described the opening ceremonies and the inaugural session presided over by Dr. G. Fromandi, Farbenfabriken Bayer AG, president of the Society, and some of the social and other activities of the meeting, together with abstracts of papers on elastomers, synthetic fibers, and vulcanization.

We continue now with abstracts of additional papers on vulcanization and papers on testing methods, tires and, more papers on elastomers. Abstracts of the remaining papers given at this meeting will be concluded in our next issue.

Abstracts of Papers *(Continued)*

Testing—I

The Dynamic Properties of Compounded Rubbers. A. Influence of Test Conditions. D. Bulgin, G. D. Hubbard, G. Lamming, M. Madden, H. Schilling, Dunlop Rubber Co., Ltd., Birmingham, England; Hanau, Germany.

This paper deals with the changes in resilience and E* modulus which result from variation of temperature, frequency, and amplitude of the test conditions.

Tests over a frequency range 0.1 cps. to 3 K.cps. —50 to 150° C. and amplitudes 0.005 to 30% on natural rubber and Krylene gum and black-loaded materials have been made by a series of methods—torsion pendulum, forced vibrations and deflections, and wave propagation.

The general pattern of results shows a systematic change of resilience and modulus with frequency and temperature including shift of the second-order transition temperature. A frequency temperature transform based on the rate process theory is obtained in the form $w = Ke^{-B/RT}$, where w is the applied frequency, T is equal to °K., and K and B are constants for the material.

The modulus of stocks containing carbon black is high and invariant at amplitudes below 0.1%, but above this value it decreases rapidly. It also decreases with increase in temperature.

This is due to the break up of carbon-carbon structure based on cohesive forces between the carbon particles.

At frequencies above 2 K.cps. the resilience of black-loaded materials becomes higher than that of gum stocks, and this is attributed to the widening of the loss peak due to the increase in damping.

There is also evidence that discrete dispersive regions arise in the loss curves due to structural factors associated with the black and polymer.

Dynamic Properties of Compounded Rubbers. B. The Effects of Polymer, Cross-Link Density and Carbon Black. D. Bulgin, I. A. Clayton, G. D. Hubbard, M. Madden, H. Schilling, Dunlop Rubber Co., Ltd., Birmingham; Hanau.

In this paper the study of the factors which influence resilience and modulus is extended to the effect of polymer, cross-link density, and carbon black. This analysis is based on deriving E′ and E″ from E* and resilience and relating these separately to cross-link density, carbon content, and type of polymer.

When carbon is added to the two polymers, a carbon-carbon structure is set up which results in a high level of E′ modulus in the unstrained stock. With increase in temperature or with increasing amplitude of deformation this structure breaks down so that at high amplitudes the modulus approaches that of the gum stocks. The E′ modulus of the compounds with undisturbed black structures is dependent on the surface area of the black.

There is also a carbon polymer interaction which results in an increase in cross-link density in carbon-loaded polymers. In such compounds the loss modulus E″ depends largely on the black content and on the type of polymer and is independent of amplitude of deformation which indicates that it arises from carbon-polymer and not from carbon-carbon interaction.

The resilience value R for natural rubber and Krylene gum stocks will depend on the value of the exponent E″/E′ and so will depend on the relative values of E″ and E′ under the given temperature, frequency, and cross-link density conditions.

When black is present, the value of E′, but not that of E″ will also depend on the amplitude of deformation in addition to the above factors, so that at low amplitudes the high value of E′ gives high resilience rubbers and *vice versa* at high amplitudes.

New Methods of Testing Rubber Vulcanizates. R. Clamroth and R. Ecker, Leverkusen, Germany.

New testing machines, improved or developed by the authors in recent years, are discussed. The first is a Roelig-type damping machine which now permits direct readings to be made of the phase angle and at the same time permits more accurate determination of static prestressing of the sample. The relation of dynamic modulus to amplitude and static modulus mean deformation was examined on unfilled and HAF black compounds; in addition, the static modulus measured at small deformation was related to the dynamic modulus. Next, results are discussed of fatigue tests under biaxial stresses made with apparatus similar to the Gehman machine, especially in relation to mechanical stresses (amplitude, mean deformation, frequency,

A view of the auditorium in the Congress Hall during the inaugural session. In right foreground, R. G. Seaman, RUBBER WORLD, listens to a translation of the special lecture on synthetic rubbers; on his right, P. D. Brass, United States Rubber Co., Paris, France

phase. angle,) the processing of the sample (thickness, direction of calendering, curing time) and the material (polymer type and filler). Results of biaxial fatigue in relation to frequency were compared with tear strength at rates of deformation up to 20,000% and measuring data were evaluated by means of electronic calculators. Finally, the authors consider abrasion tests with two machines designed on the Lambourn principle, one equipped with emery wheels, and the other with emery bands. Abrasion values on tires, obtained by these methods, were compared with DIN values, road tests, and tests on the Nurnburg race course.

New Abrasion Studies Based on the Dunlop-Lambourn Principle. D. Beckmann, Fulda, Germany.

Laboratory tests were conducted with a new abrasion tester operating on the Dunlop-Lambourn principle and equipped with a wide drum. Findings on the relations of energy, slippage, and abrasion, using variable parameters, were studied. Taken individually, it could be shown that Abrasion A, as a function of Slippage S in the range of $1.5\% < S < 7\%$ can be described by a function $A = kS^c$, where k is a material constant, and c probably is an apparatus constant. Slippage, at low values, is proportional to transmitted energy, then rises sharply until at maximum energy values skidding starts. In this connection it is suggested that the Dunlop-Lambourn principle should be used for easy determination of road adherence and skid resistance of compounds. It was further found that if limited to quality, correlation of laboratory results with practical results is largely satisfactory.

The Relation of Elastic Constants of High Polymers to Temperature. F. W. Backes, Munich, Germany.

Vulcanizates of natural rubber and various synthetic elastomers were subjected to dynamic tests in a wide range of temperatures (from −70 to +150° C.) to determine the relation of elasticity constants to temperature. The effect, especially at low temperature, is discussed of fillers, active and inactive carbon blacks and zinc white, and of built-in plasticizer content in oil-extended rubbers. Plexiglas and Mowilith [poly(vinylacetate)] were also examined under the same test conditions. With the aid of Maxwell model diagrams, the mechanical behavior of a plastic-elastic body can be clearly discussed and described by various connected mechanisms, and the method was applied to a study, on PMA esters, of material constants associated with individual mechanisms, as E modulus and relaxation time, particularly in relation to low temperature. It was found that when a simple Maxwell model is used, the E $(t = 0)$ modulus cannot be satisfactorily solved by means of the dynamic modulus.

Methods for Cold Testing High Polymers. O. Umminger, Marl-Huls, Germany.

Known and, in part, standardized methods of cold testing high polymers are known and compared; special consideration was given to the following: (1) Determination of damping [DIN 53 513 (Roelig)]; (2) Torsion vibration test [DIN 53 445 (Schmieder-Wolf)]; (4) Stiffness of non-rigid plastics as a function of temperature [ASTM D 1043-51 (Clash-Berg)]; (6) T-50 test (ASTM D 599-55); (7) Softening point [BS 1493 (1948), Appendix F]; (8) Brittleness temperature (ASTM D 746-57T).

Results of investigations lead to the conclusion that for characterizing the cold behavior of high polymers tests 1, 2, 7, and 8 are usefully discussed. It is proposed to make the Schmieder-Wolf torsion vibration test, as specified for plastics, standard for rubber also.

IR Hardness, Micro Hardness, and Shore Hardness. F. Handler and P. Kainradl, Vienna, Austria.

A general review of hardness in vulcanizates, of deformation characteristics of vulcanizates, and their relation to elasticity modulus, is followed by a discussion of the penetration process in hardness testing by the ball-indentation method: reference is made to Scott's work. His empirical formula for the relation between ball diameter, load, degree of penetration, and tensile modulus was amplified by the author's pressure measurements, and a good correspondence was found with Scott's equation. The latter is very similar to the Hertz theoretical equation.

The developments leading to the IRH test are briefly reviewed and the mathematical relation between IR hardness scale, the E modulus and degree of penetration is worked out. The IR hardness and the micro indentation testers (Wallace) are described, and effects of test conditions discussed. The Shore hardness tester is critically examined; it is found to be less accurate than the IRH tester. Several other devices are also critically considered, and test results by the various methods are compared.

Results of comparative statistically evaluated measurements indicate that there is no simple, general relation between Shore and IR hardnesses. The blunt cone of the Shore device gives greater penetration than the IR ball: strain distribution is different. Though calculations and measurements show good correlation between the two methods for elastic compounds, differences in load/deformation behavior and flow in vulcanizates lead to significant differences between the data for the two hardnesses. The authors found good correlation between the E modulus and Vickers hardness in vulcanizates having up to 90 hardness units so that a correlation can also be established between Vickers and IR hardnesses.

Special Tire Subjects

Improved Tire Performance with Synthetic Rubber. J. A. Louland and R. J. Brown, Goodyear Tire & Rubber Co., Akron, O.

World pressure for increased supplies of rubber has resulted in increased manufacturing facilities for SBR and has stimulated the development of new types of polymers. Two of these new polymers, *cis*-1,4 polybutadiene and *cis*-1,4 polyisoprene, are discussed.

Basic laboratory physical properties, factory processing problems, and full-scale road test evaluations are presented. These are the preliminary studies which prompted The Goodyear Tire & Rubber Co. to begin construction of two new manufacturing facilities to produce these two polymers under the trade names, Budene and Natsyn.

Cord Path in Tires. V. E. Gough, Dunlop Rubber Co., Ltd., Birmingham.

Reference is made to a formula which has been used to calculate tire ply material dimensions. It is noted that although this formula has given useful service in general, it is, in a number of important instances, in error.

A study of the problem has shown that it is not possible to obtain closed mathematical functions which determine cord paths and ply dimensions; on the other hand, a process somewhat akin to navigation along a cord path on the tire profile surface is of universal application. Steps are taken along a cord path, and each increment is resolved into a system of coordinate dimensions specific to the given tire surface shape. The coordinates of the starting points are known, and account is kept of the changes in coordinates as the steps are taken along the cord. This can always be done.

Central importance is given to a chart of the cosine of the cord bias angle plotted against radius to the axis of rotation of the tire as this not only enables the resolution of the cord paths into the surface coordinates, but also gives a means of defining cord paths and of examining the cord movements during manufacture. This diagram is particularly suited to this purpose for several related reasons.

A cord path produced by trellising of cords without slippage corresponds to a straight line through the origin of the chart, and geodetic paths correspond to hyperbola asymptotic to the axes of the chart. Furthermore, the movements of cords without slippage correspond to a straight line through the origin, while cord extension without slippage or trellising is represented by a hyperbola asymptotic to the chart axes. The chart is therefore a sensitive means of discriminating between various types of cord paths and the factors

producing them and of the cord movements occurring during manufacture.

The system of analysis can be extended to the calculations of cord paths on a tire of any profile shaped up from any type of cord path on any type of former by any process of manufacturing No assumptions are inbuilt in the analysis, but are introduced by, and are always under the control of, the user of the method.

Further Studies on Measurements of Deformation with Extensometers on Tires during Inflation and Rolling. F. W. Kern, K. Hafner, and H. Nippold, Munich.

The possibilities are reported of evaluating strain measurements by means of highly deformable measuring elements on tires. Chiefly considered are deformations in radial, tangential, and cord directions at typical places. The simplest estimate is based on the hypothesis that the values of expansion +E and of compression —E determine the stress on the tire materials (rubber and cord).

By means of deformation measurements in the three directions mentioned, or with cord at 45 degrees or in any other direction, the two-dimensional deformation state at the particular place can be established; hence deformation in the main or any other directions can be calculated, or some statement can be made about shear. A simple method of approximation is explained by which maximum shear can be determined. The extent of deviations in the angle between main direction and radial direction which may occur during inflation and rolling of the tire was investigated with the aid of an electronic calculator. This investigation yielded information which makes it possible to draw trajectories and to obtain a graphic picture of the dominant deformations and effective forces in the flattening zone of the tire.

Origin of Tire Squeal. R. F. Miller and J. G. Slaby, B. F. Goodrich Research Center, Brecksville, O.

The origin of tire squeal has been investigated by analysis of the movements which occur in the contact of a tire with the road during cornering and braking. The method in which cornering forces are developed is reviewed to show that the gross movements which occur are closely related to cornering squeal. A photograph of a tire through a glass roadway shows the major distortions which occur in the development of these cornering forces.

Greater detail in the contact movements has been observed from mirrors scratched by the tires during cornering. Enlargements of these scratches show vibratory movements which give rise to the sound recognized as squeal. These records show that the tire buckles in a

Dr. Fromandi presiding at inaugural session of DKG conference

region near the center of the contact, and that the squeal originates around the edges of this region where contact pressure is low and unstable.

Small pieces of tread stock were made to squeal by rubbing them over a mirror surface. The resulting scratch vibrations have been correlated with the sound recorded by a nearby microphone.

The Radial Stiffness of the Pneumatic Tire. D. H. Cooper, Dunlop Rubber Co., Ltd., Birmingham.

It is postulated that, when considering the stiffness of a tire subjected to a radial load applied by means of a plane normal surface, the load may be considered to have two components, one of which is carried principally by the structure, and the other principally by the air.

As a result of this, the radial load supported by a tire under any conditions of deflection and pressure is expressed in terms of three constants for the tire. The constants may be determined from a lattice plot of two or preferably more load-deflection curves according to a procedure described in detail. The lattice plot not only allows interpolation and extrapolation of results, but provides greater accuracy than curves passing through one origin and enables the self-consistency of all results to be immediately cross-checked.

Elastomers—II

Quantitative Infrared Spectroscopic Determination of Rubber Isomers. T. Kimmer, Schkopau, Germany.

Practical infrared spectroscopic analyses were conducted by three methods, as follows:

(1) Instead of the customary method of using olefins to measure absorption bands, a special procedure was developed (the theory of which was discussed in an earlier article) in which, with the aid of a series of dilutions and a modified base line process, "fictitious" extinction coefficients were calculated for three isomeric bands, at 910 cm^{-1}, 970 cm^{-1}, and 740 cm^{-1}, for rubber solutions of the same qualitative, but different quantitative composition. These values were used in a system of determinants to calculate the mol fractions of rubber isomers in the individual mixes as well as for the extinction coefficient of the pure isomer $_{\alpha}E^{0}$ for concentration C=0.

(2) From the average values of a large number of $_{\alpha}E^{0}$ values and by measurement of the extrapolated "fictitious" extinction coefficients, the mol fractions $_{\alpha}E$ of the rubber isomers X were calculated according to the formula

$$\times = \frac{{}_{\alpha}E}{{}_{\alpha}E^{0}}$$

More accurate values are obtained in this way than by method 1.

(3) Calibration curves were calculated for 1,2-1,4-*cis* and 1,4-*trans* isomers, which permit the proportions of rubber isomers to be read off with sufficient accuracy for general analyses.

A method was also described for determining polystyrene content in polybutadiene/styrene copolymers, in which the usual determinant equation is replaced by the modified base line process, permitting separate determination of the proportion of copolymerized styrene by infrared spectrography.

Identification and Quantitative Determination of Elastomers in Rubber. H. Feuerberg, Berlin-Dahlem, Germany.

While Burchfield's pyrolytic method of identifying elastomers in rubber is well suited to its original purpose, it is often not sufficiently accurate for the rubber analyst, largely because the pyrolysis conditions are inadequately defined. A process has, therefore, been developed for which exact conditions are laid down and which gives reproducible results. Pyrolysis is carried out in vacuum with simple apparatus, at a temperature of 650° C. for five minutes, a method under which many fillers undergo hardly any change.

The author described his methods for qualitative identification of natural rubber, SBR, butyl rubber, chloroprene and nitrile rubber; some of the methods are capable of being extended to quantitative determinations of these materials. In connection with quantitative processes, some ASTM and other methods are described and critically examined. Finally, an outline is drawn up for qualitative and quantitative rubber analysis which may facilitate the work of identification and quantitative determination of elastomers.

Capillary Rheometry as a Technique for Predicting Processing of

Elastomers. C. C. McCabe and N. N. Mueller, E. I. du Pont de Nemours & Co., Inc., elastomer chemicals department, Wilmington, Del.

The flow properties of elastomers provide a basis for predicting processing characteristics and are usually determined by measurements which relate a shear stress to some shear rate. Many instruments are available for obtaining such measurements. In this paper the use of a capillary rheometer is described, and data obtained from it are used to predict processability of neoprene. Limited results for other elastomers are also included.

The capillary rheometer to be discussed consists of a constant-temperature chamber with a circular orifice described by its diameter and its length to diameter ratio. A piston coupled to a driving mechanism through a force measuring gage is used to extrude polymer through the orifice. Shear stress-shear rate data are collected for various elastomers at selected temperatures over a wide range of shear rates. Characteristic curves are then drawn for each elastomer and form the basis for processability comparisons. Interpretation of the data enables one to predict extrusion rates, die swell and extrudate smoothness.

Similar curves are obtained for each individual elastomer containing increasing amounts of fillers or specific compounding ingredients in a given formulation. The quantitative effect of interaction between compounding ingredient and polymer is established from comparisons of these curves. It is then possible to predict processing characteristics for specific compounds by determining only the characteristics of the base elastomer and applying a suitable correction based on the interaction effects previously determined.

Determination of Small Quantities of Monomers in Latex. J. Brodsky, Gottwaldov, Czechoslovakia.

The gas chromatography method described permits direct determination of monomers in latex. The latex samples are injected into the dosing apparatus which is heated to a definite temperature appropriate for the individual tests. Water vapor and the monomers are carried over to the chromatographic column by the carrier gas (hydrogen). The water vapor collects on the column of an efficient drying agent, and the monomers separated are identified by means of the thermal conductivity cell. Conditions for determining free styrene, chloroprene, and acrylonitrile monomers are fixed. Conversion factors for quantitative evaluation are calculated.

The method is quick, simple, and accurate; individual monomers are identified in about eight minutes, and monomer concentrations to 0.02% can be determined. In comparative tests, results for styrene in butadiene/styrene latex showed good correspondence with those obtained by the distillation method.

(To be concluded)

Ontario Considering New Research Center

A committee of Canadian industrialists headed by N. S. Grace, general manager, Dunlop Research Center in Toronto, Ont., has been formed to investigate the idea of a new cooperative research center in the Toronto-Hamilton area of Canada. An expanding Ontario Research Foundation would be the focal point of the new project, and companies would be invited to locate their laboratories in the new area. ORF's scientific equipment, technical libraries, and knowledge would be readily available to all participants.

Total expenditures for research in Canada have been running around $200 million a year or about one-half of 1% of the gross national product, as compared with the nearly 3% spent in the United States. A number of smaller firms in Canada are considering research for the first time, and other companies are thinking of separating their research activities from their manufacturing operations because research personnel are becoming too involved in operating problems. The new industrial research center would be of considerable interest to such firms.

Texas Polymer Group

A polymer chemistry group affiliated with the Southeastern Texas Section of the American Chemical Society, recently was formed in Houston, Tex. The new group has 61 charter members representing 27 Gulf Coast companies. Membership is open to all members of the American Chemical Society.

G. W. Daues, Monsanto Chemical Co., Texas City, chairman of the group, said its objectives are to foster the exchange of ideas, establish educational programs to keep pace with technological advances in the field, and promote polymer chemistry.

Prof. Murray Goodman, Polytechnic Institute of Brooklyn, spoke on "Influences of Polymer Stereochemistry of Properties" at the first meeting.

NCRG Fetes Presidents

The Northern California Rubber Group held its fifth annual Past Presidents' Night, October 13, at the Elks Club in Berkeley, Calif. Seven of the 17 presidents who have served since the Group's founding in 1942 were present. They were Halsey C. Burke, Burke Rubber Co., Inc.; William H. Deis, Merck & Co., Inc.; William D. Good, American Rubber Mfg. Co.; Ralph T. Hickcox and Russell D. Kettering, both of Oliver Tire & Rubber Co.; Drace Kutnewsky, Burke Rubber; and Fred W. Swain, R. D. Abbott Co., Inc.

The dinner speaker, James F. Carey, McKinsey & Co., San Francisco management consulting firm, spoke on "Building Your Management Job." He said that what was necessary for management success was basic management skills, willingness to put forth extra work, directing the ability and extra efforts toward solution of major company problems, and willingness to expand the job by adding functions and responsibilities that contribute to the company's advancement.

Attending the annual NCRG Past Presidents' Night were *left to right:* William H. Deis, Ralph T. Hickcox, Halsey C. Burke, Russell D. Kettering, Fred W. Swain, Drace Kutnewsky, and William D. Good

Tires, SBR Production Featured In Southern RG Symposia

Symposia on tires and on SBR production were the highlights of the Southern Rubber Group meeting, October 7 and 8. The symposium on tires included discussions on tire construction and design, tire compounding, and tire manufacturing. The SBR panel covered basics of SBR production, packaging, and quality control.

In addition to the technical program, the usual social hour and a banquet were held Friday evening. Speaker for the dinner was Jack Petty, Graduate Supply House, New Orleans, La. Mr. Petty gave a very humorous talk on selling, with some pertinent pieces of advice worked into the frivolous basic theme.

The group meeting was held at the Hotel Roosevelt in New Orleans, with a very large number of members in attendance. With almost 300 men and close to 100 women present, the meeting set a record. It was also announced that the renewal of membership campaign was well on its way with about three-fourths of the members having renewed by or at this first meeting of the season.

A very special feature of the banquet program was the presentation of the Group's Harmon Connell Scholarship Award. This award, honoring the memory of the Group's first chairman, is presented annually to an outstanding student at Mississippi State University. The presentation was made by James P. McKenzie, Copolymer Rubber & Chemical Corp., to H. O. Holland, Jr., a chemistry senior at the University. Mr. Holland confirmed the wisdom of the committee's choice with his very fine, well-thought-out, and delivered brief word of thanks and appreciation.

Tire Symposium

The talk on **"Tire Construction and Design"** was given by J. L. Killian, International B. F. Goodrich Co. Mr. Killian pointed out that, while the pneumatic tire may appear to be a rather commonplace article, this amazing structure presents very definite engineering challenges. The many tire uses, passenger, truck, aircraft, off-the-road, and farm, while having much in common in design, do present individual problems in meeting the needs of each type. The speed at which almost every one of these types operates has made it a difficult task to keep ahead in tire design of the demands being imposed.

The speaker listed as specific considerations in the design of a tire nine points: (1) softness of ride, (2) smoothness of ride, (3) handling, (4) noise level, (5) durability, (6) traction and skid resistance, (7) power consumption, (8) high speed durability, and (9) appearance. Each point was discussed in some detail, with additional points made regarding the many variations possible within each type of tire.

J. P. McKenzie presenting Harmon Connell Scholarship Award to H. O. Holland, Jr.

A paper on **"Some Concepts of Tire Compounding,"** prepared by I. J. Sjothun, was delivered by K. W. Brandau, Firestone Tire & Rubber Co. In this talk tire compounding was described as the science of designing stocks to obtain (1) the desired quality or ultimate properties of the finished product, (2) acceptable processing characteristics commensurate with the equipment on which the compounds are to be processed, and (3) a cost level which will permit its acceptability. This paper dealt primarily with the quality aspects since ingredients and equipment descriptions are quite readily available.

This discussion covered the various compounding demands of each step in the production from dispersion and order of addition in mixing, through processing and into curing, pointing out how proper compound design can minimize or eliminate poor quality in each phase. Included were comments on the use of various rubbers, both natural and synthetic, and the use of ingredients such as antioxidants and antiozonants for final product quality.

A verbal trip through a tire production unit was given by R. H. Williams, Armstrong Tire & Rubber Co., in his talk, **"Tire Manufacturing."** The speaker took each phase of the making of a tire in logical order and discussed each step. This tour started in the mill room; took in the calendering of the fabric; hit on the production of white sidewalls, curb guards, and flippers and chafers; included bead forming, extruding, and flipping; collected all these components at the tire building machine; covered tire curing including post-inflation and conveying to next step; described the finishing operations of sorting, coating, inspecting, and approval; and wound up with a look at the warehousing and shipping areas. Included in each step were a description of the equipment involved, some problems encountered, and in some cases an idea of the cost of the machinery used. Williams' final comments gave an insight into the constant research and development programs needed by each plant to keep abreast of needs in compounds, equipment, and designs.

SBR Production

First speaker on the Saturday morning panel was J. D. Sutherland, Copolymer Rubber, who covered the **"Basics of SBR Production."** Dr. Sutherland gave a very complete picture of this operation, starting with a historical review of chemistry and government operation. He then included some discussion on the two monomers, styrene and butadiene, as well as very vivid descriptions of the other materials used in SBR manufacture. These include soaps, secondary emulsifiers, modifiers, initiators, electrolytes, oxygen scavengers, shortstops, antioxidants, extender oils, carbon black, and coagulation materials. Each was covered with regard to its

Southern RG tire symposium panel included *(left to right)* K. W. Brandau, R. R. Adams, moderator, J. L. Killian, and R. H. Williams

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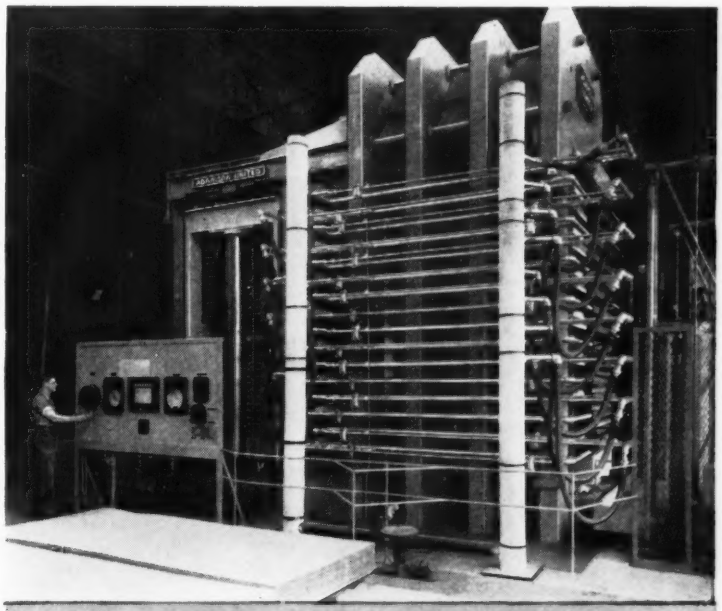

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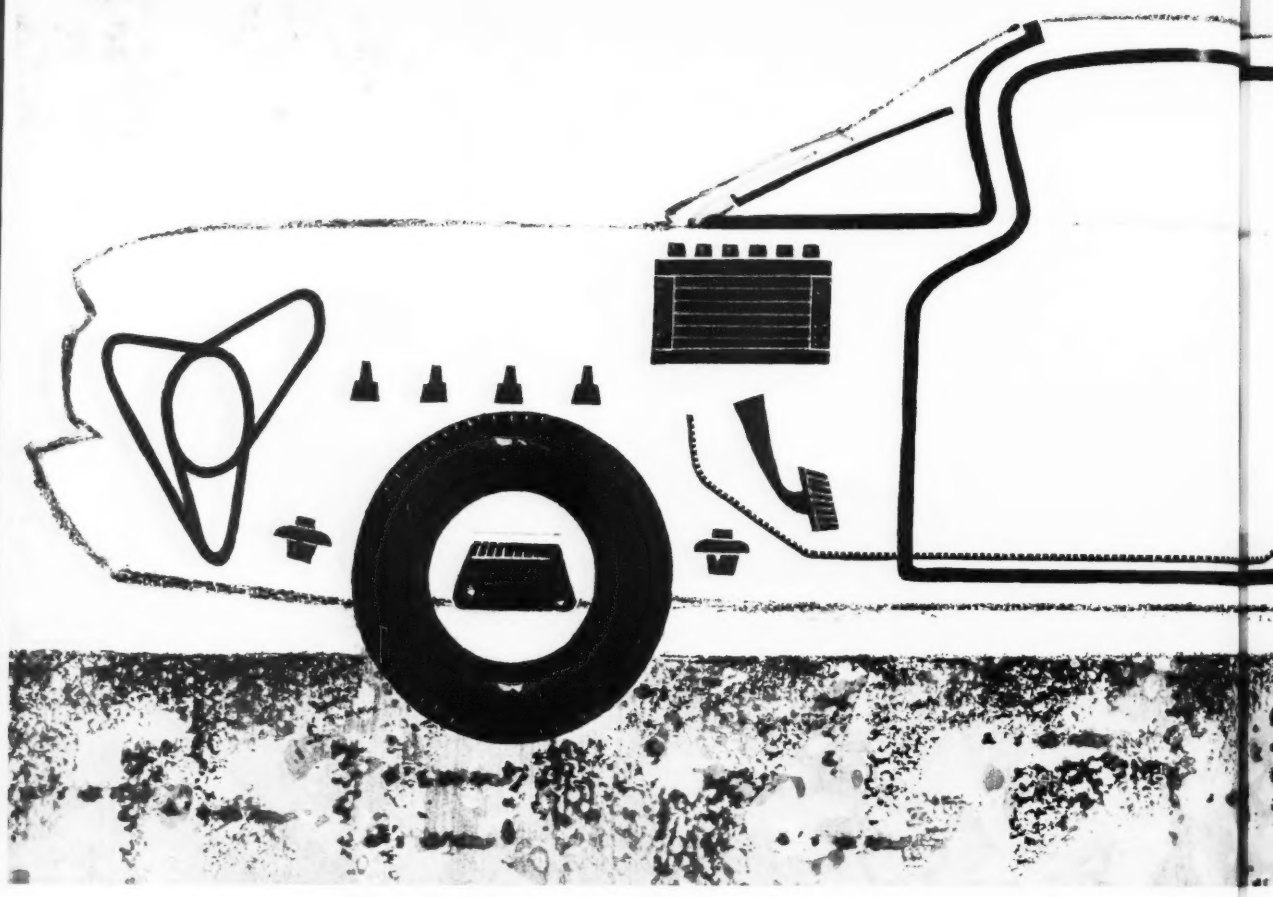

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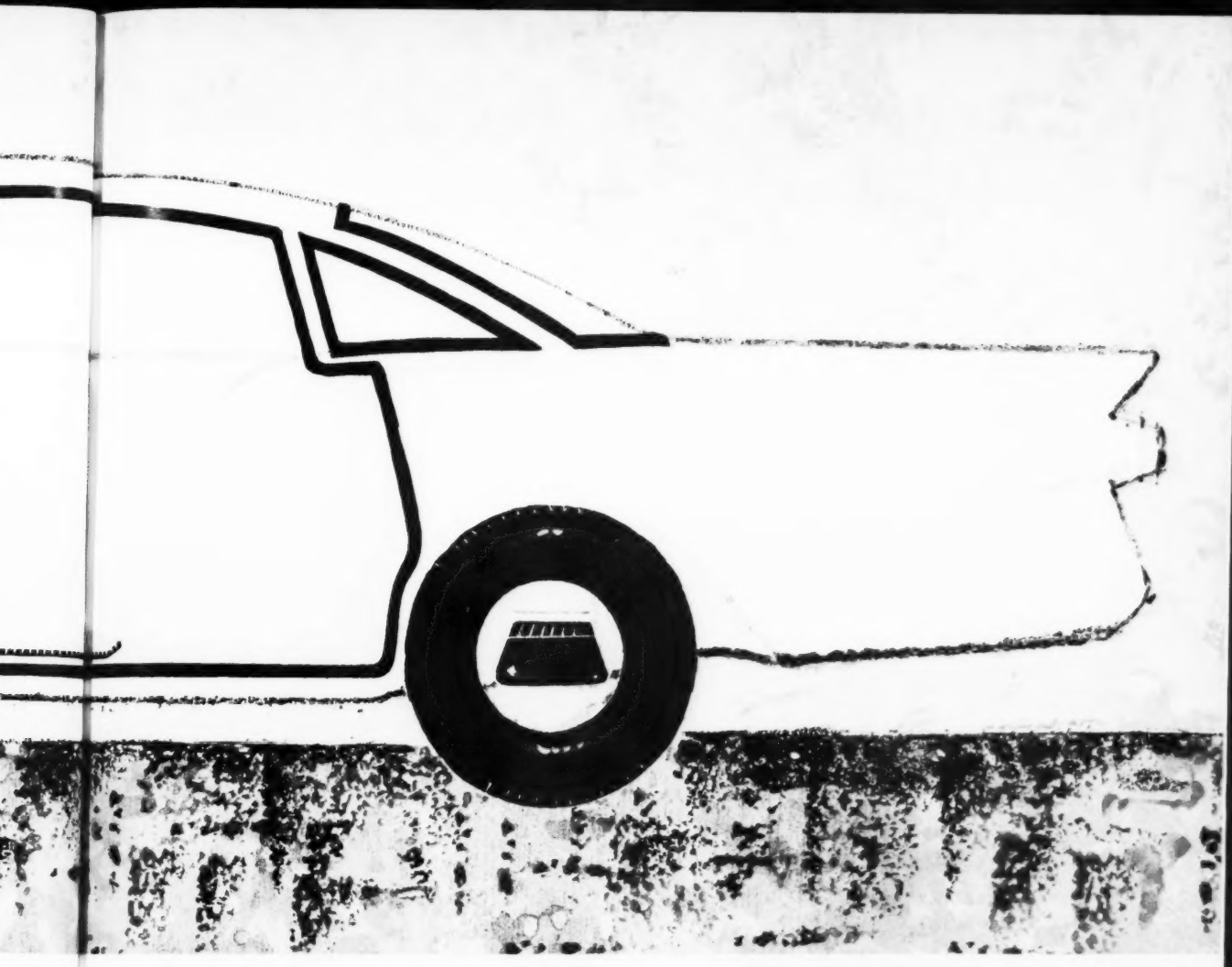

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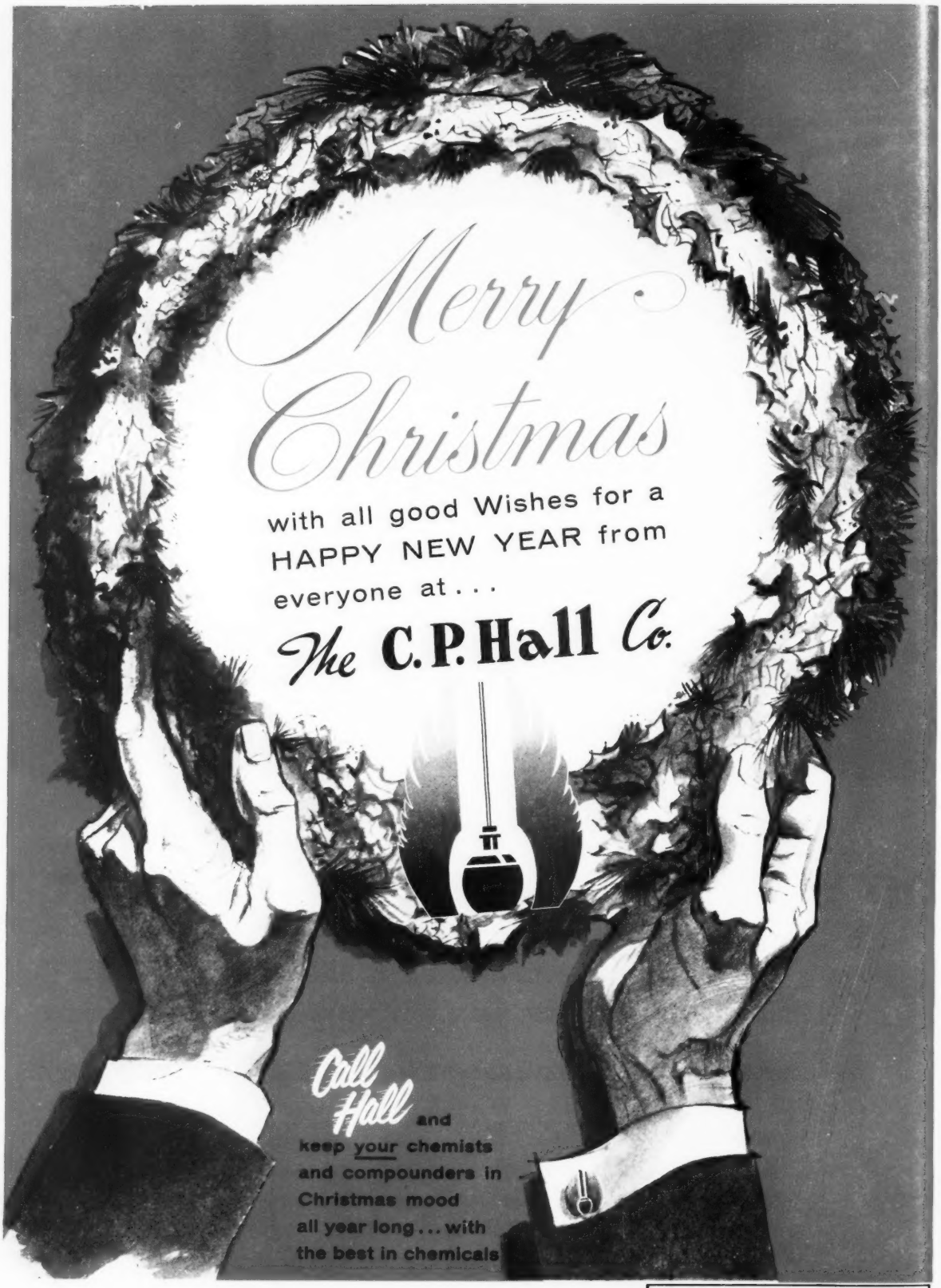
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function and with an indication of the amounts used.

The remainder of this talk was devoted to the actual equipment and steps involved to produce this polymer. Starting with the tank farm this speaker's presentation covered the pigment section, reactor section, recovery section, concentration, and finishing section. He noted that the producer does not consider the product really finished until it has been successfully used by the customer, and that all of the SBR producers have technical service available as close as the customer's phone.

The problems of containers for SBR were presented by P. C. Baker, Goodrich-Gulf Chemicals, Inc., in his talk, **"Packaging of SBR."** Mr. Baker made the point that the major problems in packaging SBR derive from the fact that SBR is a liquid, but is handled like a solid. While resistant to flow, SBR can, and does, seek its own level, as does any other liquid. There is also the problem of SBR's tendency to adhere to almost any container. These characteristics are further complicated by the fact that rubber is a material which must be handled in large volume and under a variety of conditions.

The speaker covered in some detail the origins, development, and current practices involved in the packaging of SBR in the 10 different methods now in use. These include (1) film wrapped, and in paper bags, (2) dusted with talc, and in paper bags, (3) film wrapped, and in laminated burlap bags for export, (4) dusted, and burlap bags, (5) film wrapped, and in unit cartons, (6) palletized on cardboard pallets, (7) palletized on double-faced skids, (8) palletized on single-faced skids, (9) palletized in any of the above methods to a height of five, six, or seven tiers, and (10) palletized on skids of special dimensions. He pointed out that multiplying the number of SBR types by this list of packaging methods creates a considerable inventory problem as well for the producer.

A typical program for **"Quality Control of SBR"** was the subject covered by E. T. Panowich, The General Tire & Rubber Co. He described the three main considerations of a quality control program as raw material, in-process, and finished product steps. He commented in detail on each of the raw materials as listed above by Dr. Sutherland, with the addition of the water used which also must be controlled. Panowich then described the steps taken to insure proper control of the rubber during processing and finally included the inspection tests for final quality certification of the finished product. It was noted that while actual steps vary somewhat in the three areas, the basic procedure is the same. The quality control program must start with the setting up of specifications and procedures, include the analyses of the material, and then follow up on the results, procedures, and handling as the product is in process. These steps include dealing with analyses submitted by raw material suppliers and complaints from consumers. The application of standardized test methods, started by the government and carried out and refined by private industry alone or in concert through ASTM, have enabled the SBR industry to produce a very uniform quality product that has done much to help the synthetic rubbers displace natural rubber in many applications.

SBR production was discussed for the Southern RG by *(left to right)* M. Lange, moderator, J. Sutherland, E. Panowich, and P. Baker

Rhode Island Club Elects Officers

Walter Blecharczyk, Davol Rubber Co., was elected chairman of the Rhode Island Rubber Club at its fall meeting on November 3. Some 200 members and guests attended the dinner and technical session, held at the Pawtucket Country Club, Pawtucket, R. I.

Other officers elected were Edwin C. Uhlig, United States Rubber Co., vice chairman; Joseph Vitalie, Crescent Co., Inc., secretary-treasurer; and C. A. Damicone, Acushnet Process Co., Joseph M. Donahue, chemical division, Goodyear Tire & Rubber Co., Paul Hastings, Kleistone Rubber Co., Inc., Vincent Casey, J. M. Huber Corp., and Tom Crosby, H. Muehlstein & Co., Inc., directors. Roy G. Volkman, transferred to Passaic, N. J., by U. S. Rubber, resigned as permanent historian.

H. A. Winkelmann of Dryden Rubber Division, Sheller Mfg. Corp., spoke on the variations between results of ozone aging tests under laboratory conditions and those in the conventional outdoors exposure tests. Tests exhibited differences between ozone-box aging and aging on rooftops in very cold weather or under conditions of strong sunlight and also exhibited differences in variations between static and dynamic aging. No correlation between laboratory testing and outdoor exposure can be assumed valid without extensive cross-checking, he said.

He also warned that conditions of the test must be the same as those in ultimate service and that antiozanants and waxes should be used according to results of tests, not according to technical material provided by suppliers.

Pat Abruzzi, a former member of the Montreal Alouettes, spoke on Canadian football.

Tlargi Meeting

Uses of magnesium oxides as a vulcanizing agent were outlined by William H. Deis, of Merck & Co., at the November 1 meeting of The Los Angeles Rubber Group, Inc. Some 85 members and guests attended the technical session at the Biltmore Hotel, Los Angeles, Calif., and 190 the dinner.

Deis explained that magnesium oxide with a high surface activity gives best results in neoprene, chlorobutyl, and SBR rubbers; magnesium oxide with intermediate to low surface activity best results in fluoroelastomers; and low-activity magnesium oxide best results in "Hypalon" and butyl rubbers.

He noted that surface activity is not always a reliable indicator of curing performance, since performance can sometimes be affected by the type and amount of curatives, fillers, and other compounding ingredients. In addition to surface activity, as defined by iodine adsorption, ignition loss, impurities, and particle size of magnesium oxide are properties important to the compounder, the speaker declared.

Deis further noted that magnesium oxide sometimes serves a double purpose as a retarder and a curative. He also indicated that the active types of magnesium oxides are most used in the rubber industry, but that the highly calcined, rather inactive type, does find some use.

Arthur L. Bietz, the dinner speaker, spoke on the necessity of having a sense of humor.

Rubber, Carbon Black, Tire Output Growing Abroad, Akron Group Told

The rapid growth in plant capacity of synthetic rubber abroad will cut U. S. exports by about 25% in the next five years, and rapid growth is also to be expected in production of natural rubber, carbon black, and tires, members of the Akron Rubber Group were told at a symposium on "Changing World Markets," held at the Sheraton Hotel, Akron, O., on October 28.

Approximately 350 members and guests attended the symposium and dinner which followed. Speakers for the symposium included J. D. D'Ianni, assistant to the vice president of Goodyear Tire & Rubber Co.; H. C. Bugbee, president of Natural Rubber Bureau; John Andrews, assistant director of foreign operations for Cabot Corp.; and Charles W. Rippey, project engineer for the Firestone Tire & Rubber Co. Dick Groat, shortstop for the Pittsburgh Pirates baseball team, was dinner speaker.

Synthetic Outlook

U. S. exports of synthetic rubber, expected to hit an all-time high of 300,000 tons this year, will drop to about 225,000 tons by 1965, Dr. D'Ianni told the Group.

The estimated world production figure for 1960 is 2,782,000 tons, rising to 4,364,000 tons in 1965, compared with U. S. production figures of 1,682,000 tons, or about 59% of the total this year and 2,247,000 tons, or about 55% of the total, in 1965.

Compared with this increase of nearly 12% a year in production, consumption is expected to rise by about 4.5% a year in Western Europe and 3% in the United States for the period. The result, the speaker said, will be an excess world capacity of 20 to 22%.

By 1965 our exports will be mainly in specialty types of rubbers such as stereo rubbers, hot non-staining rubbers and latex for foam, tire dip, and other applications, Dr. D'Ianni declared.

He added that our exporters operate under a number of difficulties, including duties and export quotas in many countries, ability of foreign competitors to sell on credit backed by government insurance, and an 8-10-day time lag necessary to obtain a government export license designed to prevent shipments to Iron Curtain countries. The license is necessary despite the fact that foreign producers using U. S. processes ship freely to Communist countries, he stated.

Dr. D'Ianni added, however, that even if markets for standard synthetic rubbers are no longer available to U. S. manufacturers, highly organized American research and development programs should give manufacturers a lead in selling new polymers and keep up a sizable volume of exports.

Plants currently in production in the USSR, East Germany, and Poland are estimated to have a capacity of 626,000 tons a year, and with the addition of plants in China, Czechoslovakia, and Rumania, Iron Curtain countries will have an estimated 974,000 tons of synthetic rubber a year, he said.

Table 1 shows estimated production abroad, not counting the Iron Curtain countries.

NR Production Increasing

Bugbee told the Group that the annual production of natural rubber is expected to go from 1,895,000 long tons in 1959 to 2,570,000 long tons in 1970. The largest increase will be in Malaya, where production will go from 700,000 tons to 1,200,000 tons, he said. Africa is expected to show an increase of half, from 140,000 long tons to 210,000 long tons, he stated, and most of the Asian countries are expected to show increases, many sizable.

Table 2 shows 1959 figures, in long tons, and those estimated for 1970.

TABLE 2

Territory	1959	1970
Malaya	700,000	1,200,000
Indonesia	720,000	700,000
Thailand	170,000	230,000
Ceylon	90,000	140,000
Viet Nam and Cambodia	110,000	150,000
India	25,000	
Sarawak	45,000	
British North Borneo	20,000	150,000
Burma	10,000	
Other Asia	5,000	
Total Asia	1,895,000	2,570,000
Latin America	30,000	30,000
Africa	140,000	210,000
World	2,065,000	2,810,000

Bugbee said the most important factor in increased yields is replanting programs. In Malaya, he went on, a sizable replanting program to replace low-yielding rubber with high-yielding materials is supplemented by better tapping procedures and hormone yield stimulants for the older trees.

The high-yield trees planted during the 1930's have a yield of 900 pounds per acre a year, and present selected budding material gives an average of 1,500 pounds an acre. More than half, 56% of the total of two million acres of estate rubber in Malaya, has been replanted, and 24% of the 1,500,000 acres of smallholder rubber has been replanted.

In order to increase replanting by smallholders (farmers with less than 100 acres of land planted in rubber), the speaker continued, approximately $200 in U. S. money is given him to cover his replanting costs, the funds derived by an export tax on smallholder rubber.

"Malaya is a free country, of course, and no compulsion can be applied on individuals to hasten the replanting effort; however, the financial grants plus the persuasive effect of the various campaigns to encourage replanting have done a great deal toward insuring the smallholder's future when rubber prices decline, as they may some day, to a level closer to the GR-S (SBR) selling price," Bugbee stated.

Excess Seen for Carbon Black

Andrews said that production capacity for carbon blacks in the United States has declined slightly over the past few years, while plant capacity in the rest of the world is climbing sharply. Furnace black capacity in the United States is increasing, but there is a continual decrease in channel black facilities, he said, adding, "There is strong reason to believe that rubber channel black will no longer be produced in the United States within a very few years."

World capacity of oil furnace blacks has increased by 1.2 billion pounds in the past 12 years, he declared. England has plant capacity of more than 320 million pounds; Germany, capacity of 150 million pounds; Canada, 125 mil-

TABLE 1. 1965 PLANNED CAPACITY, 1,000 LONG TONS

Country	SBR	IIR	CR	NBR	Stereo	Total	1960	1962
U. K.	103	30	20	12	30	195	81	180
France	90	20	0	5	30	145	25	85
Germany	120	0	10	5	20	155	65	125
Italy	70	0	0	5	20	95	35	85
Netherlands	55	0	0	5	0	60	60	60
Total West Europe	438	50	30	32	100	650	266	535

Country	SBR	IIR	CR	NBR	Stereo	Total	1960	1962
India	30	0	0	0	0	30	0	30
Japan	63	0	10	5	10	88	53	53
Australia	30	0	0	0	0	30	0	30
South Africa	20	0	0	0	0	20	0	0
Brazil	40	0	0	0	20	60	0	40
Argentina	40	0	0	0	20	60	0	0
Mexico	20	0	0	0	0	20	0	0
Total	243	0	10	5	50	308	53	153

New officers of the Akron Rubber Group, checking arrangements for the Group's October meeting are, *left to right*, I. J. Sjothun, chairman; B. N. Larsen, treasurer; R. B. Knill, secretary; and J. H. Gifford, vice chairman

lion; France, 200 million pounds; Holland, two large plants; Italy, 120 million pounds; and so on.

By about 1962 the United Kingdom and Europe together will have about one-third as much carbon black capacity as the United States, and all foreign countries together will produce about half as much as the United States.

The main reason for expansion of plant capacity outside the United States is that the rest of the world is rapidly catching up with the United States in consumption of carbon black and will soon surpass it, he said. One of the main reasons is that other countries are starting to buy more cars, he added.

In the United States there is one car for every three persons, leaving little room for vast expansion of car buying, but in the rest of the world there is a vast unsatisfied market for autos, he explained.

European Tire Production

Rippey agreed, noting that although the United States now produces 554,000 tires a day of a world total of 995,025 tires, and that while United States auto production was declining 26% from 1955 to 1959, West Germany doubled production, England increased its production by 72%, and France by 70%. The increased foreign auto output has created a tremendous need of expanded tire production abroad, he said.

He explained that one of the problems in marketing tires abroad is the great difference in tire designs. In France the preference is for low profile tires, but this style is not accepted in the United States, with the European area preferring deep tread designs, and North and South America the shallower tread. Likewise there are differences in ply and tread design preferences, he said.

Rubber Materials Book Coming

The third edition of the very popular "Compounding Ingredients for Rubber" is now on the press and will be available for distribution in the near future. This book, the only one of its kind in the United States, contains complete lists of all compounding materials including auxiliary materials. It also contains listings for rubbers, reclaims, and latices.

Price of the book is $15.00 in the U. S., $16.00 elsewhere.

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CALENDAR of COMING EVENTS

January 17
Elastomer & Plastics Group, Northeastern Section, ACS. Science Park, Boston, Mass.

January 19
Quebec Rubber & Plastics Group.

January 20-21
Southern Rubber Group. Statler-Hilton Hotel, Dallas, Tex.

January 27
Akron Rubber Group.
Chicago Rubber Group. Furniture Club, Chicago, Ill.

February 7
The Los Angeles Rubber Group, Inc.

February 9
Fort Wayne Rubber & Plastics Group.

February 17
Detroit Rubber & Plastics Group, Inc.

February 24
Quebec Rubber & Plastics Group. Ladies Night. Victoria Hall, Westmount, P.Q., Canada.

March 7
The Los Angeles Rubber Group, Inc.

March 10
Chicago Rubber Group. Furniture Club, Chicago, Ill.

March 17
Boston Rubber Group. Hotel Somerset, Boston, Mass.

March 23
Quebec Rubber & Plastics Group.

March 24
New York Rubber Group. Henry Hudson Hotel, New York, N. Y.

April 4
The Los Angeles Rubber Group, Inc.

April 6
Akron Rubber Group.
Rhode Island Rubber Club.

April 18-21
Division of Rubber Chemistry, ACS. Brown Hotel, Louisville, Ky.

April 19
Quebec Rubber & Plastics Group.

April 21
Detroit Rubber & Plastics Group, Inc.

April 28
Chicago Rubber Group. Furniture Club, Chicago, Ill.

May 2
The Los Angeles Rubber Group, Inc.

May 21
American Chemical Society, St. Louis, Mo.

June 2
Quebec Rubber & Plastics Group. Golf Outing. Ste. Hyacinthe, P.Q., Canada.

June 8
New York Rubber Group. Outing. Doerr's Grove, Millburn, N. J.

June 16
Akron Rubber Group. Firestone Country Club.
Boston Rubber Group. Outing. Andover Country Club, Andover, Mass.

June 23
Detroit Rubber & Plastics Group, Inc.

June 23-24
Southern Rubber Group. Buena Vista Hotel, Biloxi, Miss.

washington report

By JOHN F. KING

Eisenhower "Buy-American" Order Should Increase Rubber Exports

If President-elect John F. Kennedy lets stand one of the last executive orders issued by President Eisenhower, the rubber industry will start selling a good deal more of its products to government purchasing agencies.

Eisenhower on November 17 issued a sweeping directive to all federal agencies with overseas operations to cut back sharply on their procurement of foreign goods and services. Put another way, the Chief Executive told them to reorient their offshore buying programs to a "Buy-American" basis, that is, to give preference to U. S. suppliers over foreign suppliers.

Notably included in this order was the International Cooperation Administration and the Defense Department, which annually spend nearly $3.5 million on foreign goods overseas each year under the military and economic aid programs. The offshore buying budgets of these two programs long have been eyed by U. S. suppliers of everything from clothing to automotive equipment as a prime market; until now, however, the agencies involved refused to accept buy-American policies and insisted on buying most of their needs abroad, where it was felt prices were lower. Companies in the rubber industry, as well as in scores of other industries in this country, long have demanded that the aid agencies channel more of their procurement funds to U. S. suppliers.

Sets Overall Policy

The President's directive, which supersedes piecemeal policies such as that adopted October 6 by the Defense Department (see RW, November Washington Report), also ordered the Defense and State departments to halt the purchase of foreign goods to stock such government stores overseas as military post exchanges and embassy commissaries. These too, henceforth, are to buy only American goods.

The Chief Executive's directive was capped by the most dramatic move of all—the recall home of some 284,000 dependents of U. S. troops stationed overseas. This part of the executive order represented such a switch in postwar U. S. international policy that it provoked protests from some of Eisenhower's own official family. Army Secretary Wilbur Brucker publicly criticized the President, by indirect comments on the Presidential order, indicating his belief the dependent recall would undermine the morale of U. S. forces abroad. Less publicly, State Department officials worried that the morale and effectiveness of the foreign service would suffer if the President's order to all agencies to reduce their foreign staffs were carried out to the letter.

If President-elect Kennedy reverses the Eisenhower directive after taking office January 20, it will be solely because the disgruntlement in military and civilian operations overseas convinces him the savings to be made from the cutback are not worth the loss in morale.

As indicated in RUBBER WORLD in November, the President moved decisively on overseas spending because of the badly deteriorated U. S. balance of payments position. Despite Administration hopes for improvement in the situation earlier this year, the amount the U. S. paid out in international transactions over and above what it took in from foreign nations—that is, the deficit in the balance of payments—continued to grow. The riotous speculation on European gold markets late in October was clear notice to the U. S. Government that confidence in the dollar as a primary unit of international exchange had slipped badly. U. S. financial policymakers had been warned for some time by European central bankers that the payments deficit had to be corrected before they could rest easy in their mind that the dollar would not be devalued; as long as the U. S. payments deficits continued, the Europeans said, they would have no choice but to continue turning in their dollar holdings, which were growing sharply, for gold from the U. S. stock.

Deficit Continuing

When the hoped-for improvement in the deficit failed to materialize in midsummer, the gold drain from the U. S., which totaled $2.3 billion in 1958 and $1.1 billion in 1959, resumed with a vengeance. In the July-August quarter, it jumped to $650 million and continued at a high rate into the fourth quarter.

The deficit in the payments balance itself, the cause of the gold outflow which in 1960 will easily top last year's loss, rose from an annual rate of $2.9 billion in the second quarter to a whopping $4.3 billion in the third. Experts estimated that the absolute deficit at year-end would reach $4 billion, far higher than the $3.5 and $3.8 billion deficits in 1958 and 1959, respectively, which first created concern about the U. S. international financial position.

Faced with these statistics, President Eisenhower ordered the spending cutback. Altogether, according to the White House staff, the spending economies envisaged by Eisenhower will bring a reduction of $1 billion in the amount this country pays other countries each year. No one in a responsible position in the government will say so, but it is clear that the Eisenhower Administration regards the balance of payments situation with such gravity that it would not hesitate to take even more drastic action—such as a clampdown on the amount U. S. tourists may spend or the amount U. S. companies may invest abroad—should the deficits continue.

Aid from Allies Sought

What the Kennedy Administration will do should the situation in 1961 remain unchanged remains to be seen. One thing is certain: President Kennedy will pursue one line of action the

Eisenhower Administration opened late this year in connection with its drive to redress the payments deficit. This is the insistence that U. S. allies in Western Europe pick up more of the cost of maintaining defense systems on the Continent. This means particularly that West Germany should contribute substantially to the cost of keeping U. S. troops there.

While Eisenhower's spending cutback order was drastic, it does not in fact prohibit U. S. agencies from buying foreign goods, except in the case of PX's and commissaries abroad. It does, however, direct for the first time that "very substantial" reductions in the amount spent abroad should be undertaken before the end of this year. Specifically, here are the directives to each agency:

- In addition to ordering the military services to reduce the number of dependents overseas from 484,000 to 200,000, both the Defense Department and its Military Assistance Program agencies should establish "a minimum amount by which such (foreign) procurement shall be reduced."
- The State Department's International Cooperation Administration should "adopt a policy which will place primary emphasis on financing goods and services of U. S. origin in all of its activities." ICA shall also place a "ceiling" on all of its operations which do not finance direct procurement of U. S. goods and services. "The amount of commodities now being purchased aborad with ICA funds shall be reduced to the lowest possible figure."

Ever since about 1954, U. S. industries, not the least of which is the rubber industry, have been exerting heavy pressure for such a directive from the President. What happens as a result of the new policy adopted in the last hours of the Eisenhower Administration is entirely up to John F. Kennedy.

Economic Outlook For 1961 Not Too Bright

The current economic recession—if that is what it may properly be called—apparently will be with us for some time. Economic analysts who early this year looked for 1960 to mark with dramatic new records the opening of the "Soaring Sixties" now are scaling down, with some disappointment, their initial projections for the decade. The consensus seems to be that 1960 clearly did not live up to expectations and that 1961 will show only moderate improvement. With regard to the 1961 outlook, a good many of the analysts seem to have their fingers crossed.

The great question mark in the puzzling idleness in the economy is the unwillingness of consumers to spend. What makes the consumer question even more frustrating to analyze is the established fact that the average consumer's disposable income rose sharply through the year—up 7% in the second quarter over the first and another 3.4% in the third over the second. All sorts of explanations for this development are advanced—the consumer is saving more; he is spending more for services than goods; he is investing more heavily in intangibles such as education, insurance, and so on.

Consumer Not Spending

But the fact remains—and is attested to by the fact that there were over one million 1960 model cars still on the hands of dealers when Detroit began pouring out the 1961 models this fall—that he is not spending. Besides autos, the consumer's recently acquired propensity not to spend shows up in sales of consumer durables other than autos, which were weak through the third quarter, and in the slump in residential construction.

The consumer's central role in the current economic slowdown is underlined by the softness in business investment in new plant and equipment. While this sector of the economy is some 10% higher than a year ago, the rate of increase is down considerably. Businessmen, watching the consumer spending figures and his own sales statistics, are not anxious to embark on investment programs that may only add to the substantial amount of idle industrial capacity that exists now.

Inventories Reduced

Likewise on business inventory, the industrial buyer is reluctant to stock up, particularly if he thinks there may be some price-cutting as a soft tone in the economy continues. This inventory hesitancy can be traced through 1960 as follows. In the first quarter business inventories were being built up rapidly at an annual rate of $11.5 billion, partly reflecting the rise in orders for steel and steel mill products depleted by the 1959 strike. In the second quarter the inventory annual rate plummeted to $5 billion, and in the third inventory buying slowed to a stop. In the last couple of months inventory reduction has been the order of the day.

Some Bright Spots

Against this picture of an idling economy, there are some strong plus factors. Purchases of goods and services by government—federal, state, and local—rose appreciably and, with increased spending ordered for some defense programs and highway construction, should remain a reinforcing feature of the economic picture into 1961. Exports also continued strong, running well ahead of last year's.

Perhaps most important is the easing of credit that has been permitted by the monetary authorities. Besides the general lift less-expensive money gives to the economy as a whole, it is expected to boost key sectors such as residential building.

But more than anything else, the consumer holds the key to the economy in the year ahead. As stated by Woodlief Thomas, Economic Advisor to the Federal Reserve System, "Resumption of economic expansion in the near future . . . will depend more largely upon the whims of consumers and the actions of producers and distributors in adapting their products, prices and selling practices to those whims, than upon Government policies."

Railroad Rates Cut For Carbon Blacks

Effective October 25, the Southwestern Railroads put into effect a reduction of approximately 20¢ per hundred weight on carload rates for carbon black shipped from southwestern points to destinations in the so-called Western Trunk Territory of the railroads, which includes Chicago, Ill., Eau Claire, Wis., Des Moines, Iowa, Minneapolis and St. Paul, Minn., and Omaha and Lincoln, Neb., and points in between.

The Traffic Committee of The Rubber Manufacturers Association, Inc., estimates that the lower rates will reflect a savings in freight rates paid by the rubber industry of about $3 million a year, based on carbon black shipments of 1.5 billion pounds in 1959. This does not count savings of about $700,000 to the carbon black industry in elimination of freight costs which are normally absorbed by the carbon black firms.

Carbon black rates to West Coast destinations had earlier been reduced by about 15%, and the Traffic Committee is working to bring about further reductions.

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Goodrich Offers Akron Old Miller Plant Site

The B. F. Goodrich Co., Akron, O., has offered Akron the site of the former Miller Rubber Co. as an outright gift. This includes 16 buildings on about 13 acres in the south of the city.

Goodrich bought the company in 1930 and used it to produce rubber sundries until 1957, when the operations were moved to more modern plants. The site has since been unused.

Pending the acceptance by Akron's City Council, one or several of the city's departments will be moved to that area. The city has outgrown its facilities some time ago, and this gift would provide badly needed space.

World, Rubber, and Export Economic Outlook Given to RMA Annual Meeting

United Press International

R. L. Reierson

A program of economic advice was presented to a record group of the rubber industry's executives at The Rubber Manufacturers Association, Inc., annual meeting held at the Essex House, New York, N. Y., on November 17.

The speakers' subjects in the morning session covered the battle between various synthetic rubbers as well as synthetic *versus* natural rubber for the increasingly competitive rubber market, a discussion on the economic picture in the United States today with some predictions and warnings for the future, and a panel on the effect of exports on our economy and suggestions as to what should be done to increase these exports.

The luncheon program included introductions of head-table guests, an announcement of new RMA Directors, and an announcement of the establishment as a full division of RMA of the former Molded, Extruded, Lathe-Cut, and Sponge Rubber (chemically blown) Products Subdivision.

The new directors are George R. Vila, president, United States Rubber Co.; M. G. O'Neil, president, The General Tire & Rubber Co.; and J. H. Hoffman, president, Mansfield Tire & Rubber Co. In addition, five directors were reelected. They are A. H. Wechsler, vice president and general manager, Converse Rubber Corp.; R. C. Firestone, president, Firestone Tire & Rubber Co.; A. Kelly, executive vice president, The B. F. Goodrich Co.; E. J. Thomas, chairman of the board, The Goodyear Tire & Rubber Co.; and H. E. Humphreys, chairman of the board, U. S. Rubber. The terms of Mr. Hoffman and the five reelected members expire in 1963; while Mr. Vila, filling the place of J. W. McGovern, will serve until 1962, and Mr. O'Neil, replacing his late father, W. O'Neil, will serve until 1961.

Test Tube *versus* Tree

At the conclusion of his welcoming remarks Ross R. Ormsby, president, RMA, introduced the first speaker, R. P. Dinsmore, vice president, Goodyear. Dr. Dinsmore spoke on the "Battle between the Tree and the Test Tube." He pointed out that synthetic rubber has reached a point where it can compete with natural rubber on a quality basis so that now the problem becomes one of cost. Several charts were presented that show a predicted excess of overall rubber production capacity for the foreseeable future that should create a strong buyer's market with its price depressing effect. Dinsmore's discussions on the stereo specific polymers of isoprene and butadiene suggest that it will require further reductions in raw material costs before either of these two polymers will really be competitive in cost in the range of present SBR grades at which natural rubber may well stabilize its current decline in price.

Must Ease Dollar Drain

The second speaker was R. L. Reierson, vice president and chief economist, Bankers Trust Co., who discussed the general economic picture in the United States and the world and warned the new administration that one of its foremost tasks will be to come to grips with the internationally weak position of the United States dollar. Dr. Reierson said that "it appears imperative to resort to a much greater extent than heretofore to the practice of 'tied' aid, i.e., easing the drain on the U. S. gold stock by rendering aid through greater exports of goods and services rather than by making dollars available that may be spent anywhere in the world."

R. P. Dinsmore

He criticized military spending abroad both on the basis of adding to the dollar drain as well as the oft-repeated claims made by friends and allies that our military establishments are too luxurious. A reduction in these expenditures would reduce pressures on the balance of payments and, as a by-product, probably help create a more favorable public opinion abroad.

Dr. Reierson presented a series of charts on various facets of the economy

and its progress over the past several years, prepared by the economics department of Bankers Trust, and concluded by saying "at the moment, probably nothing could contribute more to the restoration of confidence in the dollar than concrete evidence that the new administration intends to keep the federal budget under control, preserve the independence of the Federal Reserve, and refrain from curtailing the exercise of a flexible credit policy."

United Press International

C. P. Taft

Export Policy Debated

The final section of the morning session was devoted to a panel debate on exports policies of the United States. The panel was moderated by C. P. McFadden, RMA, and consisted of H. B. McCoy, president, Trade Relations Council, and C. P. Taft, general counsel, Committee for a National Trade Policy.

Mr. McCoy proposed a "live and let live" trade policy that will not injure either U. S. or foreign industry. He stated that most manufacturers in this country believe that we should export our products to those countries which need and wish to buy these products without consequent injury to their industrial economies and that we import materials and commodities needed and desired in this country in whatever quantities may be involved without injury to our domestic industry. Following this policy, now prevalent in most other countries, would provide ample opportunity for orderly trade expansion, but would not depress our economy.

Mr. McCoy attacked proposals that the Federal Government's main approach should be to use its funds to assist industries and localities to adjust after the injury has occurred. He concluded that "our long-time favorable competitive position has all but disappeared."

Mr. Taft, in his talk, urged that the

H. B. McCoy

United States move forward in its trade policy toward a greater reduction of barriers to international trade among the countries of the free world. He called for a new initiative on the part of the United States in maintaining and improving the Free World system of multilateral non-discriminatory trade among all countries.

He claimed that proposals that have been made for a general system of import quotas to maintain a so-called "reasonable" level of operations for basic American industries are retrogressive and self-defeating. They would relieve the industries concerned of the necessary adjustments which world competition imposes.

Mr. Taft concluded that to advocate such a system, which he called a program of isolationism or withdrawal, is a counsel of despair. It clearly suggests that we have lost our vigor and our competitive capacity and must withdraw from the competitive world.

Interpretation of Elections

The after-lunch speaker was Claude Robinson, founder and chairman of the executive committee, Opinion Research Corp. Dr. Robinson, who served with the Nixon campaign, tried to explain to the group some of the various factors which came into effect during the recent elections. He took a number of specific instances and places to point out the many national, regional, and local pressures and fears that made themselves felt in the election outcome.

Hercules Powder Buys Industrial Rayon Mill

Hercules Powder Co., Wilmington, Del., has purchased the Covington, Va., fibers plant of Industrial Rayon Corp. and will use the plant to house a newly formed fiber development department.

Hercules will convert the nylon section of the Covington plant, used for both rayon and nylon fibers production, to the spinning of polypropylene fibers, with an annual capacity in excess of 10 million pounds. The facilities will be used to produce textile staple and continuous multifilament yarns from Hercules "Pro-fax" crystalline polypropylene.

The new fiber development department will be used to evaluate and develop markets for polypropylene stable and filament yarns. It will be headed by Forest B. Evans, formerly assistant general manager of the company's Virginia cellulose department.

United Press International

C. Robinson

A. E. Forster, president of Hercules, said that the company does not intend to enter the nylon or rayon fiber fields; nor does it plan to manufacture heavy denier monofilaments.

Richardson Carbon Co. Wins Advertising Prize

The Sid Richardson Carbon Co. advertisement which appeared in the September issue of RUBBER WORLD received an international award in the 1960 competition of Affiliated Advertising Agencies Network.

The advertisement showed a silhouette of two cowboys riding on a tandem bicycle and the caption "Double Capacity." It was designed to emphasize the company's intention to enter the furnace black field when the new plant in Big Spring, Tex., is completed, and also to underline the firm's continuation in the channel black business at its Fort Worth, Tex., plant.

Thomas L. Yates, president of the advertising company which created the advertisement, presented a certificate marking the award to Frank M. Andrews, vice president and general manager of the carbon company.

The competition, held in October, included more than 800 entries from 48 U. S. cities and 11 foreign countries.

Willard Stewart, Inc.

E. R. Bridgwater

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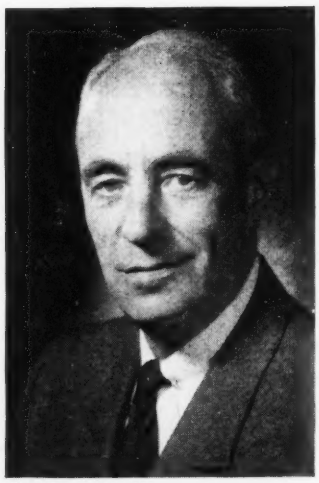
Louis W. Cabot



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Thomas D. Cabot

E. R. Bridgwater Retires from Du Pont

Ernest R. Bridgwater has retired as general manager, elastomer chemicals department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., after 37 years with the company.

He is known for his key role in commercializing neoprene. He joined the company as a rubber chemist in 1924 and became sales manager of the rubber chemicals division in 1929. Two years later he was named division manager, and in January, 1957, he became assistant general manager of the newly created elastomer chemicals department.

During the First World War, Mr. Bridgwater served in the Chemical Warfare Service of the U. S. Army. Afterward he worked for The B. F. Goodrich Co. for three years and Firestone Tire & Rubber Co. for two years before he joined Du Pont.

He is a member and a past chairman of the Divison of Rubber Chemistry of the American Chemical Society and a fellow of the Institution of the Rubber Industry, London, England. He has many patents and numerous publications on synthetic rubber to his credit.

Cabot Corp. Elects New Head, Officers

Louis W. Cabot succeeds his father, Thomas D. Cabot, as president of Cabot Corp., Boston, Mass. Thomas D. Cabot is now chairman of the board of directors.

Other executive changes in the organization include a new treasurer, William S. Edgerly, and three new directors, McGeorge Bundy, William L. Loving, and John M. Bradley. Godfrey L. Cabot, who founded the firm in 1882, is honorary chairman, while Ralph Bradley and Henry L. Shattuck are now directors emeritus.

Louis W. Cabot recently held the position of vice president and treasurer of the parent company, Cabot Corp. and its various subsidiaries. Previously he had a hand in many areas of the organization.

Thomas D. Cabot started with the firm in 1919 and helped guide it through its period of growth and international expansion. In 1951 he served the State Department as director of international security affairs.

William S. Edgerly joined Cabot in 1952. Early this year he was made assistant treasurer and head of the finance department.

Dayton Rubber Holds International Talks

Dayton Rubber International, a subsidiary of Dayco Corp., Dayton, O., held a two-week technical symposium for representatives from its subsidiaries and affiliates in 10 foreign countries during November. Representatives were present from Canada, Mexico, Scotland, Norway, Denmark, Holland, Israel, Japan, Germany, and India.

The first week of meetings and clinics was spent at the Dayton Tire & Rubber Co., another Dayco subsidiary, in Dayton. Subject matter covered developments in tires and materials, and was capped with a tour of the tire production lines at the Dayton plant.

Subjects for the second week included plastics, textile products, radiator hose, printing products, latex foam, and urethanes. Part of the second week was spent at the company's Dayco Southern division in Waynesville, N. C.

Panel discussions covered developments from angles ranging from raw materials handling and processing to production machinery. Representatives from a number of U.S. companies supplying raw materials and machinery to the rubber industry participated. The companies included Industrial Ovens, Inc., Columbian Carbon Co., Copolymer Rubber & Chemical Corp., Enjay Chemical Co., Richardson Scale Co., McNeil Machine & Engineering Co., E. I. du Pont de Nemours & Co., Inc., C. A. Litzler Co., and New Jersey Zinc Co. Three members of the mechanical engineering department of Ohio State University were also on hand to discuss design methods, stress analysis, and force and motion analysis in V-belts.

The overseas visitors represented firms which have technical assistance or licensing agreements with Dayton Rubber International.

Flo-Tronics Acquires Rubber, Plastic Firms

Flo-Tronics, Inc., Minneapolis, Minn., manufacturer of electronic controls, materials-handling systems, and plastic products for industry, has acquired Rubber Industries, Inc., of Shakopee, Minn., and Plasticos Co., Minneapolis. Purchases have been approved by the Flo-Tronics board of directors and will be submitted to stockholders at a meeting this month.

Plasticos will become part of Flo-Tronics plastics division, with Sylvester Mady, vice president and general manager of the division, heading operations. Rubber Industries, Inc., will continue under Donovan P. Stern, its present president, as a wholly owned subsidiary. The company's announcement said that the Plasticos techniques for pressure molding will supplement the injection molding production of the plastics division.

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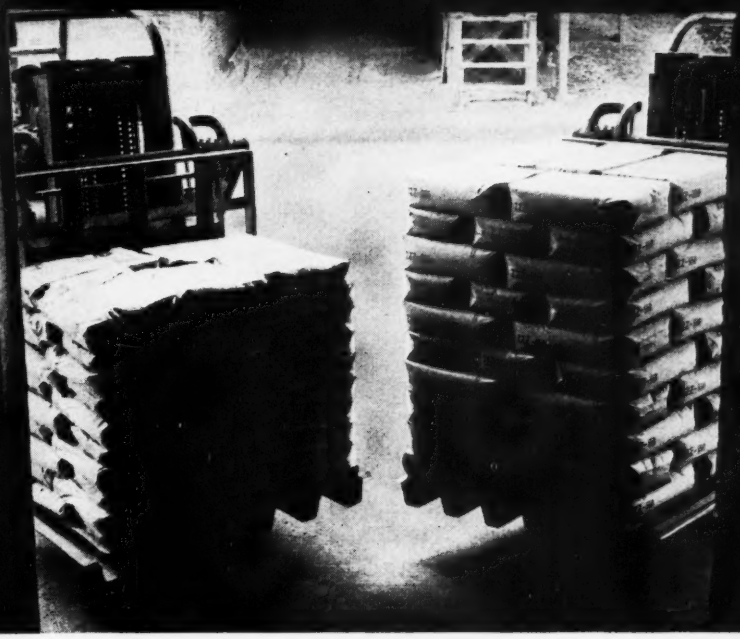

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news briefs

POLYMER CORP., LTD., Sarnia, Ont., Canada, expects to start construction soon on new facilities for black masterbatch rubbers. The facilities, to cost more than a million dollars are scheduled for completion late next year.

GENERAL TIRE & RUBBER CO. became the newest company to express interest in the field of stereospecific rubbers with its announcement that it has awarded Crawford & Russell, Inc., of Stamford, Conn., a contract to design and engineer a pilot plant for both continuous and batch polymerization of isoprene and butadiene. The plant is to be located at Mogadore, O. Two special Crawford & Russell reactors, specially designed for polymerization under very high viscosity conditions, are to be used.

SEIBERLING RUBBER CO., broke ground October 25 for a $1.5 million rubber goods plant in Batesville, Ark. The plant, to be operated by the Batesville Rubber Co., a subsidiary of Seiberling, will turn out heels and soles for shoes, and tread rubber, for both the southern and western markets. Construction is scheduled for completion next summer.

WEIGHT AND VOLUME can be cut to a minimum in space flight by use of rubber, plastics, and aluminum for equipment which will store and supply food and water for the spaceman, Lt. Col. Albert A. Taylor, Air Force expert on feeding the spaceman, indicated in a report on "Food for Space Travel." In particular, rubber bladders and gaskets will be used for water storage, he said.

LINDE CO., division of Union Carbide Corp., New York, N. Y., has given rights to manufacture and sell synthetic crystalline zeolites to Davison Chemical Co. division of W. R. Grace & Co. The agreement does not cover exchange of technical information or rights to practice any of the proprietary use methods developed by Linde. Synthetic crystalline zeolites, marketed as Linde Molecular Sieves, are used as adsorbents and desiccants. In curing of rubber they may be loaded with active chemicals and provide controlled release of these chemicals.

AMERICAN CYANAMID CO. has moved the headquarters of its petrochemicals department from 30 Rockefeller Plaza, New York, N. Y., to Bound Brook, N. J.

UNITED STATES RUBBER CO., New York, N. Y., plans to open 10 company-owned tire centers in the San Francisco-Oakland area in 1961. The move will be made to strengthen distribution of tires on the West Coast, following opening of stores in the Los Angeles area.

ACE RUBBER CO., Akron, O., held a silver anniversary party for its employes, presenting watches to six workers with 25 years of continuous service. The firm, founded 25 years ago by the late Floyd C. Snyder, is now headed by his son, Charles J. Snyder.

AMOCO CHEMICALS CORP. has moved its executive offices and Chicago district sales office from 910 S. Michigan Ave., to 130 East Randolph Drive, Chicago 1, Ill.

Locker room floors at the synthetic latex plant of Goodyear Tire & Rubber Co., Akron, O., are covered with "Dura-Grip," resin bonding agent. The concrete surface was covered with "Dura-Grip"; aluminum oxide grips were sprinkled on the wet first coat; and after drying, a second coat of "Dura-Grip" was applied. The floors are said to be safer and more durable than those made of concrete.

COPOLYMER RUBBER & CHEMICAL CORP., Baton Rouge, La., will build a new $750,000 office building on its property in Baton Rouge. No starting date for construction was given, but construction is expected to take about a year from the starting date.

E. I. DU PONT DE NEMOURS & CO., INC., Wilmington, Del., has reorganized research and development activities of its elastomer chemicals department, dividing it into a unit for "pioneering research" and one for "supporting research," both organizations housed in the recently completed elastomer research laboratory at the Experimental Station in Wilmington. John B. Campbell is laboratory director of the first group, and Malcolm A. Smook of the second.

SHELL CHEMICAL CO. will build a new polypropylene plant with an initial capacity of 80 million pounds a year, at West Deptford Township, near Woodbury, N. J. The plant uses a new process developed after considerable research, and Shell will construct at the plant a new research center and technical service center to provide technical assistance for customers.

MANSFIELD TIRE & RUBBER CO., Mansfield, O., has completed negotiations for purchase of the Pacific Tire & Rubber Co., Oakland, Calif. Mansfield has operated Pacific's tire and tread rubber manufacturing facilities since November 1, 1952. Inland Rubber Corp., a wholly owned Mansfield subsidiary, has owned 50% of Pacific stock since January, 1951, and the remaining 50% has now been acquired from Bay Rubber Co.

NATURAL RUBBER BUREAU has moved to new quarters at 1108-16th St., N. W., Washington 6, D. C.

FIRESTONE SYNTHETIC FIBERS CO. is now producing nylon filament for use in tire cord at the Hopewell, Va., plant. The plant, which is manufacturing both monofilament and multifilament nylon yarns to be made into tire cord at the company's textile plants, will produce 10 million pounds of nylon a year when in full production.

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GENERAL ANILINE & FILM CORP., Antara Chemicals Division, New York, N. Y., has announced that butenediol, previously available only in pilot quantities, will be sold in tank-car quantities in two grades. The product will be on the market about January 1. The product, an unsaturated glycol tested as a chemical intermediate for polymers, will sell for 73¢ a pound for the technical grade and 90¢ for the purified grade.

FOOTE MINERAL CO. is building a butyl lithium plant designed for a capacity of 100,000 pounds of n-butyl lithium, but expansible to twice that amount if the demand is great enough. The material, used as a catalyst for stereospecific rubbers, will be produced at New Johnsville, Tenn., as well as at existing facilities at Exton, Pa.

INTERNATIONAL LATEX CORP.'S chemical division will devote its newly expanded Tylac plant at Cheswold, Del., to custom service. Three new 3,000-gallon reactors have doubled the plant's capacity, raising it to 17 million pounds a year. Plans call for adding five more 3,000-gallon reactors to bring annual output to 36 million pounds of latex.

THE UNIVERSITY OF ILLINOIS Division of University Extension, Urbana, Ill., will give its annual basic short course in "Quality Control by Statistical Methods" from January 30 through February 9. The course is designed for those in areas of design, production, management, quality control and inspection.

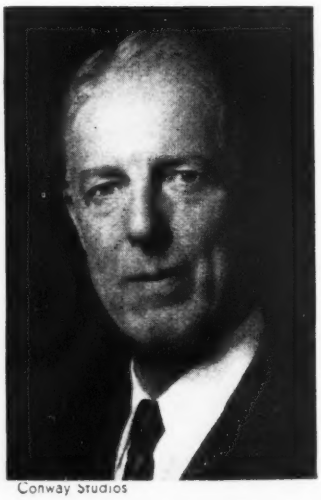
MINNESOTA RUBBER CO. rubber compound 503A, which has an NBR polymer base, has been approved by the Underwriters Laboratory for use in all types of rubber products with LP gases, gasoline, and kerosene.

SEIBERLING RUBBER CO., Akron, O., increased the prices of its earthmover tires and tubes for heavy construction and mining equipment as of November 1. The increases range from 2½ to 5%.

WORTHINGTON BALL CO. shareholders Elyria, O., producer of golf balls, have approved sale of the company to Comptometer Corp., Chicago, Ill.

STAUFFER CHEMICAL CO. has opened a sales office in the Delaware Trust Bldg., Wilmington, Del., to serve the Wilmington and Greater Philadelphia areas for both the industrial chemicals and Victor divisions of Stauffer.

obituaries



Conway Studios

Charles R. Haynes

Charles R. Haynes

Charles R. Haynes, a familiar figure in the rubber industry for many years, died on November 21 at the home of his brother in Boxford, Mass., at the age of 78 after a lingering illness.

"Charlie" Haynes was a graduate of the Massachusetts Institute of Technology, class of 1904. He worked for various rubber companies in the Boston area and elsewhere in administrative capacities before becoming the technical supervisor for the footwear factories of United States Rubber Co. in 1919. Mr. Haynes joined Binney & Smith Co. in 1935 as technical service manager and remained with that company until his retirement in 1955. In recent years he worked as a consultant chemist for National Polychemicals Co., Wilmington, Mass.

Mr. Haynes was a member of the American Chemical Society and its Division of Rubber Chemistry and served for many years as secretary of the Rubber Division. He was also active in the affairs of several of the local rubber groups and was a member of the Engineer's Club of New York.

Services were held at the Forest Hills Crematorium Chapel, Forest Hills, Mass., on November 25.

Surviving are a brother and a sister.

George L. Allison

George Lloyd Allison, Sr., retired manager of technical information for The B. F. Goodrich Co., Akron, O., died October 26 at the age of 70.

He joined Goodrich in 1917 after his graduation from college. He was first employed in the general chemical laboratories and in 1929 was made technical superintendent of processing. In August, 1943, the deceased was loaned to the government's Office of Rubber Director, War Production Board, and served there until January, 1946. He served a second tour of duty with the government from February to December, 1951.

Mr. Allison returned to Akron to become manager of technical information for Goodrich. He retired in 1955.

In addition, he was a member of the American Chemical Society, the American Institute of Chemical Engineers, and University Club; he was also a past president of the Akron Rubber Group.

He is survived by his wife, a son, a daughter, three grandchildren, and four sisters.

Services were held October 29 in the Monroe United Presbyterian Church, followed by burial in Rose Hill Burial Park, Akron.

Edward H. Lewis

Edward H. Lewis, president and founder of Western Insulated Wire Co., Los Angeles, Calif., died of a heart attack, October 4, at his home in Brentwood, Calif.

Mr. Lewis founded the company in 1937 and helped make it the largest firm of its kind west of Chicago. When the company was purchased in 1959 by Penn-Union Electric Corp., Erie, Pa., Mr. Lewis continued as president.

Before establishing Western Insulated, Mr. Lewis was associated with General Electric Co. for 12 years and held the position of chief engineer designer of conduit wires and cables. He later spent two years as general manager of Hatfield Wire & Cable Co.

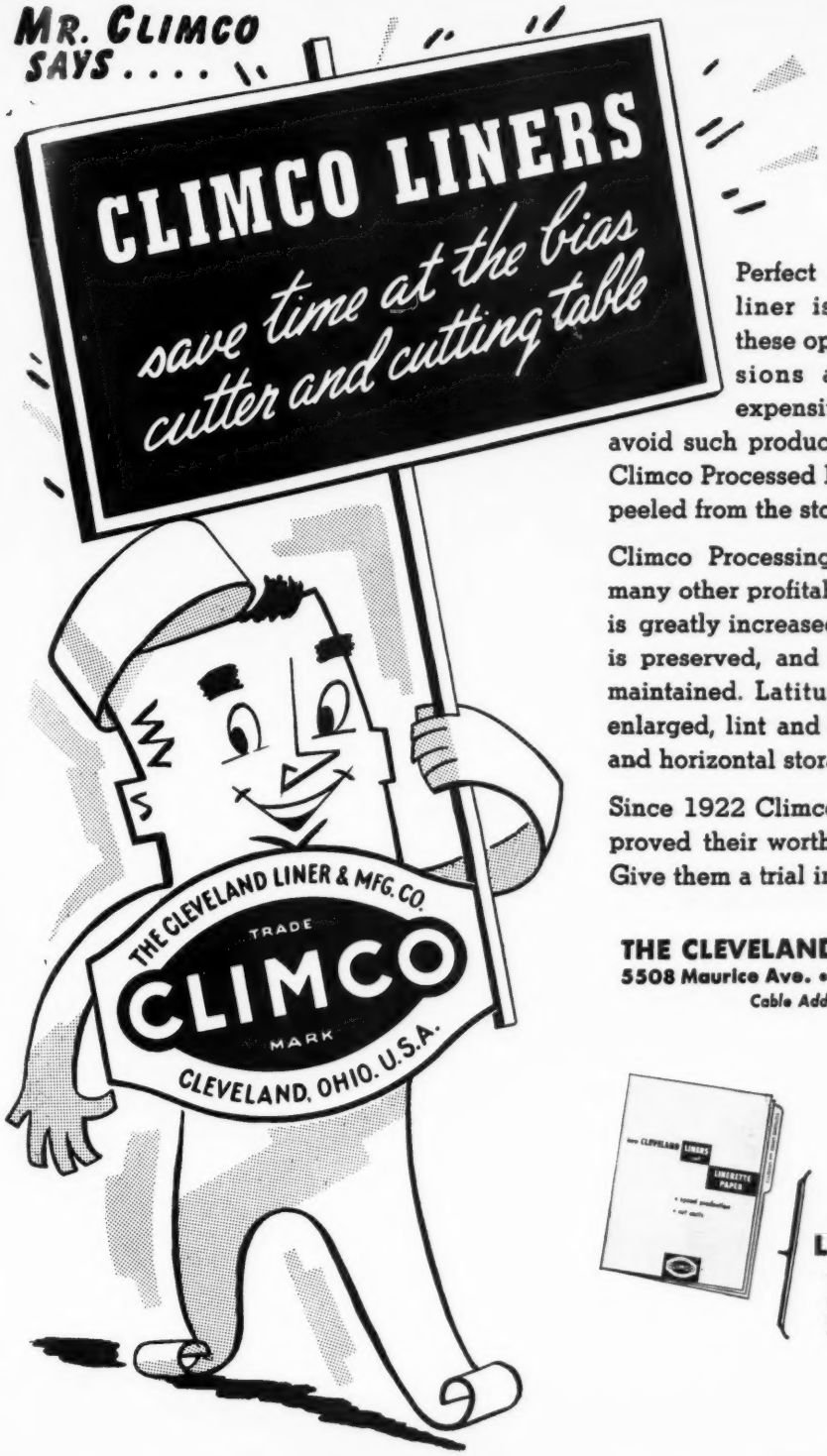
The deceased received a degree in mechanical engineering in 1921 from Cornell University. He was born in New York, N. Y., on August 28, 1897.

Mr. Lewis was a charter member of the International Power Cable Engineers Association, a member of the Electric Club of Los Angeles, National Electrical Manufacturers Association, The Los Angeles Rubber Group, Inc., American Chemical Society, and Society of Automotive Engineers. He held many patents relating to wire and cable. He was also active in civic affairs.

Funeral services were held October 7 at the Church of the Recessional, Forest Lawn Memorial Park, Glendale, Calif.

He is survived by his wife, a daughter, a sister, and three brothers.

MR. CLIMCO SAYS....



Perfect separation of stock and liner is all important during these operations—for stock adhesions at either point cause expensive down time. You can avoid such production headaches by using Climco Processed Liners that can be readily peeled from the stock without sticking.

Climco Processing of your liners assures many other profitable advantages: Liner life is greatly increased, tackiness of the stock is preserved, and gauges are more easily maintained. Latitude in compounding is enlarged, lint and ravelings are eliminated and horizontal storage is facilitated.

Since 1922 Climco Processed Liners have proved their worth to the rubber industry. Give them a trial in your plant.

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Serving the Industry Since 1921

news about people

Art Bailey

P. C. Finn

T. A. Galvin

R. H. Davis

D. Mueller

J. E. Hargreaves

Arthur E. (Art) Bailey now covers the northeastern and middle Atlantic areas as sales representative for Copolymer Rubber & Chemical Corp. He will maintain headquarters in both Hartford, Conn., and Philadelphia, Pa.

Parker C. Finn is now a sales representative for the eastern sales district of the silicone products department, General Electric Co., and will have an office in Newark, N. J.

Wyman L. Taylor has been named eastern sales manager for the industrial chemicals division, Stauffer Chemical Co., New York, N. Y. He was formerly administrative assistant to the vice president, sales. **Joseph F. Luther** has been appointed national product manager for chlorinated hydrocarbons. **Louis Taylor** becomes manager, product department, for the industrial chemicals division.

Robert S. Holdsworth has joined Dewey & Almy Chemical Division of W. R. Grace Co., Cambridge, Mass., as manager of the can-sealing compound research laboratory.

William H. MacKay, formerly secretary and vice president of industrial and public relations, Dunlop Tire & Rubber Corp., Buffalo, N. Y., is now vice president in charge of manufacturing. **R. C. V. Mackenzie** has been elected secretary in addition to his former position as vice president in charge of sales operations. **Edward C. Campbell** moves from manager, tire sales, to assistant vice president, sales.

Thomas A. Galvin has been named manager of the new U. S. Rubber Reclaiming Co., Inc., plant at Vicksburg, Miss. He was plant engineer of the company's main production facilities in Buffalo, N. Y., since 1953. Construction of the new $1,250,000 plant is nearing completion.

R. Henry Davis has been promoted to general manager, industrial rubber products division, Cooper Tire & Rubber Co., Findlay, O., and will be in charge of the operations at Findlay, and also at the Auburn, Ind., plant. Previously he was the division's sales manager.

Chris A. Stiegman is the newly elected vice president, research and development, Hooker Chemical Corp., Niagara Falls, N. Y. **J. Howard Brown,** recently appointed manager of research; **Robert F. Schultz,** new manager of process development; and **Alvin F. Shepard,** senior scientist; all report to Dr. Stiegman. **Walter S. Beanblossom** is now administrative assistant to Dr. Brown instead of to Dr. Stiegman. Other changes include **Joy E. Beanblossom,** now department head, semi-commercial operations; **David S. Rosenberg,** section manager, process development; and **Elliot P. Doane,** pilot plant supervisor. The latter three report to Schultz.

Charles H. Davis becomes a sales engineer for the Chicago, Ill., office of The Day Sales Co. and will handle sales in northern Illinois, northern Indiana, southern Wisconsin, and eastern Iowa.

John E. Hargreaves is the new president of Scott Testers (Southern), Inc., Spartanburg, S. C. He formerly was manager for the company.

Douglas Mueller, assistant to the president of Seiberling Rubber Co., Akron, O., has been named director of merchandising and public relations. He will supervise the company's advertising, sales promotion, and public relations activities.

C. H. Edwards, Jr., has been promoted to manager of the Phillips Chemical Co. Philprene specialty rubber plant at Borger, Tex. **George D. Covington** has been transferred from Providence, R. I., to replace Edwards as technical sales representative at Dallas, Tex. In addition, **W. R. Haight** moves from Akron, O., to become technical sales representative at Providence, and **F. J. Ennis** joins the Chicago, Ill., office as technical sales representative.

Robert E. DeRight has been named to direct the new far eastern division of the international department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Establishment of the division was prompted by the birth of the new Japanese company, Showa Neoprene K.K., in which Du Pont has half ownership. **Robert J. Tiews** is in charge of the group of consultants to assist in the design, construction, and start-up of the new plant which will probably be located in Kawasaki, just south of Tokyo. **William H. Dizer** will also be stationed in Japan in connection with the new operation.

as revealed in the new ASRC manual*

ASRC 3106 offers you a BIG 9% SAVINGS!

ASRC 3106...
unlike other general purpose type polymers, has an appreciably lower ash content and consequent low-moisture absorption qualities. If you have been using high-priced, low-ash polymers to compound products with medium moisture absorption requirements, ASRC 3106—priced at least 2¢ less per pound—can provide welcome savings on material costs.

SEE HOW

ASRC's General Purpose Type Polymer No. 3106 satisfies non-critical moisture absorption requirements.

SPECIFICATIONS	Minimum	Maximum	Typical	Test Methods ASTM: D1416-58aT Section
1. Volatile Matter	—	0.75%	0.25%	3-6
2. Total Ash	—	0.35%	0.20%	11-15
3. Organic Acid (Stearic)	4.75%	6.75%	5.75%	30-35
4. Free Soap	—	0.50%	0.05%	36-40
5. Bound Styrene	22.5%	24.5%	24.0%	25-29
6. Viscosity, Raw Polymer ML 212 F @ 4 minutes	46	56	50	ASTM D927-57T
7. Viscosity, Compounded ML 212 F @ 4 minutes	—	70	60	

One of Many Money-Saving Recipes with ASRC 3106!

MEDIUM HEAT RESISTANT STOCK	
ASRC 3106	100
Cumar EX	10
Titanium dioxide	10
Zinc oxide	20
Stearic acid	1.25
Sunproof wax	3.5
Hard clay	100
Agerite Stalite	1.5
Benzothiazyl disulfide	2.5
Methyl zimate	1.25
Sulfur	2
	252.00
Properties:	
Durometer, Shore A	70
Tensile strength, psi	2000
Elongation, %	850

ARE YOU processing products such as: electrical blankets, mechanical cover stocks, wringer rolls, athletic goods, medium heat resistant stocks, tape cement, electrical pads, hospital sheeting, electrical parts, gaskets, for which ASRC 3106 is ideally suited? If so, ask your ASRC man to show how ASRC 3106 can become a real money-saver for you, too. *Call him today!*

**ASRC 3106 is one of many polymers described in ASRC's new desk-side manual. Containing complete specifications on all ASRC synthetic rubbers, it is handsomely designed in an indexed, loose-leaf format. A significant addition to your technical reference library . . . the manual makes synthetic rubber selection easy as ASRC. FREE to compounders; write for your copy—on your company letterhead, please.*

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ASRC
THE FIRST NAME IN SYNTHETIC RUBBER

news about people

The Zito Studios

K. H. Stroh

Willard Stewart, Inc.

C. J. Harrington

Lubitsh & Bundarz

L. E. King

Pach Bros., N. Y.

E. S. Ebers

Pach Bros., N. Y.

D. Chittenden

K. Henry Stroh has been appointed field engineer for John Royle & Sons, Paterson, N. J. For the past 17 years Stroh has been associated with this firm of extruder builders.

Charles J. Sindlinger has been appointed manager of the planning department for Columbia-Southern Chemical Corp., Pittsburgh, Pa., to succeed **Frances A. Theis,** now president of Pittsburgh Plate Glass International, S. A. Dr. Sindlinger was director of development at Columbia-Southern's Corpus Christi, Tex., plant.

Norman A. Rautiola joins Bjorksten Research Laboratories, Madison, Wis., as assistant to the executive vice president. Prior to this appointment he was a senior patent examiner, metallurgy and semi-conductors, for the U. S. Patent Office, Washington, D. C. In addition, **Kenneth A. Bouschart** is now a staff electrical engineer in the physics division of the Laboratories.

H. R. Stitely has resigned as president of Lord Chemical Corp., York, Pa., but will continue as a director and a consultant. **Paul H. Setzler** has been named vice president and general manager. **James F. Connaughton,** president of Bell Intercontinental Corp., the parent company, succeeds Stitely as president.

Philip E. Robinson has been appointed secretary-manager of Tyrex, Inc., New York, N. Y., an association of Tyrex rayon tire cord producers. **I. Rogosin,** chairman of the board of directors, will add the title of president on January 1, following the resignation of **William Dalton.**

Robert W. Cottingham has joined Cabot Corp., Boston, Mass., as research chemist in the organic and polymer research section of the new products research department. **Robert G. Boucher** is a chemist at the Billerica Research Center, and **Norbert Olsen** is now a project engineer in the process design and economic section of the new product research department.

Charles J. Harrington succeeds **Ernest R. Bridgwater** as assistant general manager of the elastomer chemicals department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. **Lyle E. King** replaces Harrington as director of sales. Dr. Harrington has been with the company since 1933.

C. R. McGill

A. H. Davis

Alden H. Davis and **Charles R. McGill** have joined the sales service group of J. M. Huber Corp., and will be associated with the development department at Borger, Tex.

Oscar Dobkin joins the technical staff of Hughes Aircraft Co., Culver City, Calif., to serve in the applications and evaluation section, materials and processes department, product effectiveness laboratory, and will be responsible for consultation and all other aspects of design support in the rubber and elastomers fields.

William C. Fife will represent Fife Mfg. Co., Inc., Oklahoma City, Okla., in its relocated West Coast office at Downey, Calif.

Harold G. Osborn has been elected chairman of the board, Continental Carbon Co., Houston, Tex., to succeed Robert I. Wishnick, who will continue as a member of the board. Osborn is also senior vice president of Continental Oil Co.

Edward F. Johnson has taken on an assignment as area representative, industrial sales, southern territory, for Sohio Chemical Co., Lima, O.

Earle S. Ebers has been designated group vice president in charge of the polymer, fiber, and chemical operations of United States Rubber Co., New York, N. Y. He will be responsible to the president for operations of the textile, plantation, and Naugatuck Chemical divisions, and for the subsidiary, Latex Fiber Industries, Inc. **Dudley Chittenden** has been elected to succeed Ebers as vice president and general manager of the Naugatuck Chemical Division.

John von Bergen has been assigned as director of industrial sales for the air pollution control division of John Wood Co., Bernardsville, N. J. He will direct the division's program to market air pollution control equipment in a move to expand sales activities.

Richard L. Moody becomes assistant sales manager for Wilson Rubber Co., Canton, O., and will work directly with the company's sales engineers and wholesale distributors.

Thurman E. Brown has been appointed director of development for Columbia-Southern Chemical Corp.'s research and development laboratory at Corpus Christi, Tex. Since 1951 he has served as a chemical engineer in a number of capacities for the company.

Edward C. Cooney has rejoined William D. Egleston Co., Cambridge, Mass., after an 11 year absence. During that time he spent seven years with The New Jersey Zinc Co. and four years in metal sales.

Robert D. Beattie fills the newly created position of polyolefins project manager of the new products research department, Cabot Corp., Boston, Mass. Before this promotion he served as senior chemical engineer.

R. V. Boyce becomes district sales manager of the newly created West Coast sales district, Jefferson Chemical Co., Houston, Tex. The area includes Washington, Oregon, California, Arizona, Utah, Nevada, and Idaho.

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. . . for complete list of NAUGATUCK CHEMICAL ANTIOXIDANT • ACCELERATORS • BLOWING AGENTS ANTIOZONANTS • SPECIAL PRODUCTS FOR THE RUBBER INDUSTRY.

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Company.....

Address.....

City.....*Zone*.....*State*.....

Over 60 Chemicals

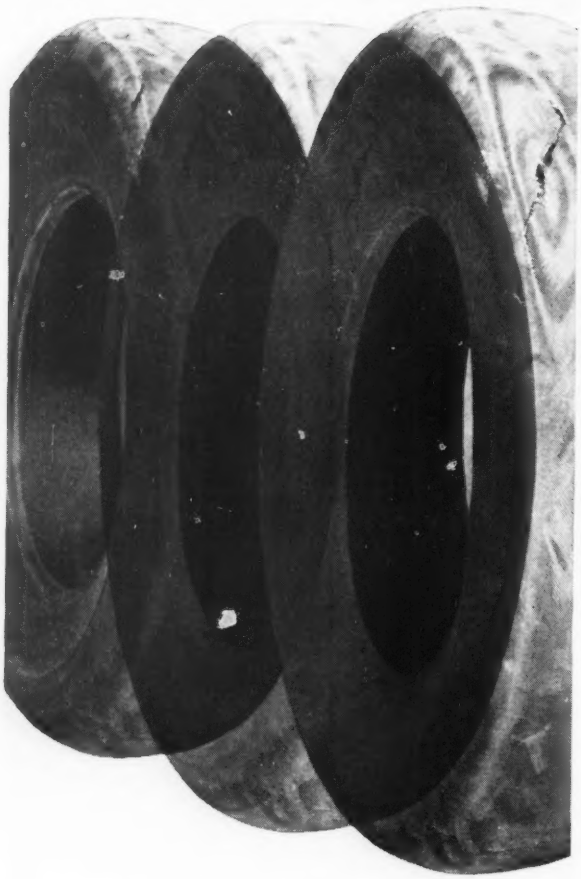
for the Rubber Industry

Naugatuck Chemical

Division of United States Rubber Company Naugatuck, Connecticut

US RUBBER

Naugatuck RECLAIM



WHEN RIDING ENDS... WALKING BEGINS...

On Heels and Soles made better by Reclaim Rubber

Many heel and sole manufacturers have already discovered that inexpensive RECLAIM rubber makes a better product, faster and at less cost, than virgin rubber.

They know shoe manufacturers benefit from the improved dimensional stability of RECLAIM. They themselves prefer RECLAIM because it offers them such advantages as:

- stable, low cost
- economical mixing
- fast processing
- less heat build-up
- rapid cure
- assured uniformity
- minimum reversion tendencies
- excellent aging characteristics

These reclaimed rubbers with their inherent advantages serve equally well for such products as mechanical goods, proofed goods and molded goods. Naugatuck has, in fact, an economical RECLAIM formulation for just about every product need—a rubber which can often outperform the rubber you are now using.

Find out about the RECLAIM formulation best for your operations. Contact your Naugatuck Representative or write us.

Naugatuck Chemical

Division of United States Rubber Company 1210B Elm Street Naugatuck, Connecticut

Rubber Chemicals · Synthetic Rubber · Plastics · Agricultural Chemicals · Reclaimed Rubber · Latices · **CANADA:** Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario · **CABLE:** Rubexport, N.Y.

Naugatuck PARACRIL OZO

Now an oil-resistant rubber with **color**

...*any* color...*any* shade...for almost any rubber product

Color is a facet of function. Color identifies... emphasizes ...warns... attracts or repels.

Color, properly used, is beauty. Color appeals. Color *sells*.

And now *all the color you can use* is yours in a synthetic rubber compound so tough, so oil, chemical, weather, and ozone resistant, it actually outperforms other rubbers. No longer need you think in terms of gray, brown, and black for any weather-resistant rubber.

Paracril® OZO—a unique blend of acrylonitrile-butadiene rubber and vinyl developed in the Naugatuck Chemical laboratories of U. S. Rubber—is already demonstrating its product-improvement power in a wide range of highly successful applications. And it's ready and waiting to do the same for *your* product.

Take a look at Paracril OZO. Full information is immediately available from your nearest Naugatuck Representative or the address below.

Naugatuck Chemical

Division of United States Rubber Company 1210P Elm Street Naugatuck, Connecticut

Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • CANADA: Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario • CABLE: Rubexport, N.Y.

New SPECIMEN DIMENSION COMPENSATOR

For Scott Model CRE Testers and ACCR-O-METER Kits

Easier than a phone call! This new Scott Tester accessory now gives you a quicker, easier, more accurate way to obtain tensile test readings *direct* in psi, kgs/cm², grams/tex or other selected bases — just by turning a dial!

The new Scott Specimen Dimension Compensator automatically adjusts test recordings for dimensional changes in specimen thickness, width, diameter, or cross-section. The operator merely sets the 20-step dial control to the measured variable of the specimen before making the test — the Scott compensator unit does the rest! On special order the number and magnitude of steps may be tailored to suit the job requirements.

The new Specimen Dimension Compensator attaches easily to your Scott Tester . . . swings back out of the way and out of the circuit when not in use. *Any* range (psi etc.) compatible with specimen size and tester capacity may be furnished. Compensator, together with push-button Range Selector, provides *multi-psi ranges* in ratios of 1, .5, .2, .1, and .05. Write *today* for complete details.

Scott Testers Inc., 90 Blackstone St., Providence, R. I. Tel. DExter 1-5650 (Area Code 401).

SCOTT TESTERS

THE SURE TEST . . . SCOTT!

news about people

John H. Gerstenmaier has been appointed plant manager of The Goodyear Tire & Rubber Co.'s Akron industrial products operations. **Paul D. Suloff,** former manager of industrial products design, succeeds Gerstenmaier as manager of industrial products development.

R. F. Dunbrook

Dunbrook Retires

Raymond F. Dunbrook has retired as assistant director of the chemical and physical research laboratories, The Firestone Tire & Rubber Co., Akron, O. He was with the company 31 years, the last 15 as assistant director of the laboratories.

He was active in the company's recent discovery of Coral rubber (*cis*-polyisoprene) and Diene (a polybutadiene for use with natural rubber in tires).

Dr. Dunbrook is also known for several standard references in rubber research. Among them are his translation of D. K. Memmler's "The Science of Rubber," from the original German, and his own review of the government research program on synthetic rubber from the viewpoint of the organic chemist. The material for the latter book, published in 1946, was collected while he served with the War Production Board and Rubber Reserve Co. for two years during World War II. This book covered the most important fundamental factors in the organic chemistry of synthetic rubber.

Dr. Dunbrook has had a hand in six patents and in 1951 patented a simplified process for continuous production of synthetic rubber. He was co-editor of "Synthetic Rubber" and author of a number of articles.

He will continue to serve as chairman of the Committee on Plastics & Elastomers of the advisory board on Quartermaster Research & Development.

George R. Wertz, Jr., has been named Chicago, Ill., district manager for B. F. Goodrich Industrial Products Co. He was formerly Minneapolis, Minn., district manager.

William H. Skelly, Jr., is now manager of the Middle Atlantic district for the industrial chemicals department, Commercial Solvents Corp., Newark, N. J., will be the headquarters for his supervision of the sales activities from New Jersey to Florida.

Walter A. Gay has joined Dewey & Almy Chemical Division, W. R. Grace & Co., Cambridge, Mass., as a research chemist in the organic chemicals laboratory.

Hugh Magee, recently appointed Vancouver technical sales representatives for Naugatuck Chemicals, division of Dominion Rubber Co., Ltd., Montreal, P.Q., will be in charge of sales of all Naugatuck products in British Columbia.

W. P. B. Gedye, of Monsanto of Canada, Ltd., Toronto, Ont., has become a member of the joint education committee of the Division of Rubber Chemistry, Chemical Institute of Canada, and the Ontario Rubber Group.

C. M. Fisher succeeds **J. N. Vaughn** as managing director of The Firestone Tire & Rubber Co. plant at Manila, Republic of the Philippines. Fisher has been in the Philippines as the firm's general sales manager. Vaughn has retired after nearly 37 years' service.

E. H. Strobel has been appointed factory manager of plant 1 at The Firestone Tire & Rubber Co., Akron, O., to succeed **H. W. Boettner,** who retired after 40 years with the company.

E. D. (Dave) Gordon is now assistant to the president of The Sperry Rubber & Plastics Co., Brookville, Ind. He was previously with Firestone Industrial Products.

M. E. Pickett, Jr., is now a vice president of Columbian Carbon Canada, Ltd., Toronto, Ont., and general manager of its carbon black and pigment division. **C. M. Croakman** continues as vice president in charge of sales for the division.

Ormond O. Black, mezzanine, the Willard Hotel, Washington 4, D. C., (DIstrict 7-6010) will cover southern Maryland, Virginia, North and South Carolina, Georgia, Florida, Alabama, and Mississippi for RUBBER WORLD's advertising sales department.

(*Continued on page 148*)

EAGLE-PICHER

...an important source of lead and zinc compounds for the rubber industry

Eagle-Picher offers you a comprehensive line of both lead and zinc compounds, produced with highest quality control standards to your exact specifications.

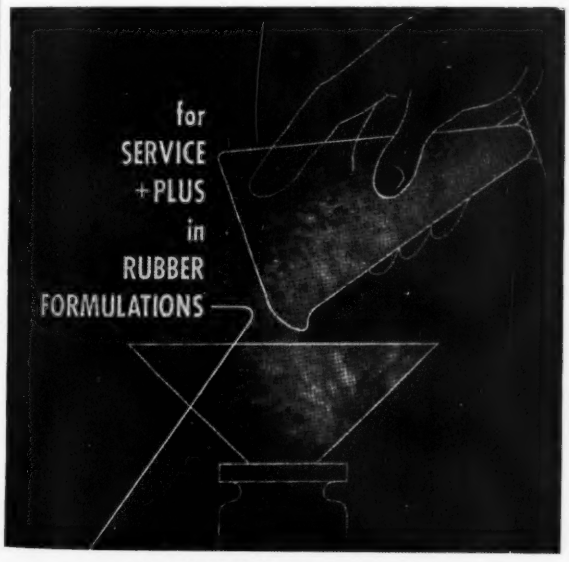
Our customer service and research staffs are geared to answer your special needs . . . with courteous dispatch and resourcefulness.

Zinc Oxides	Litharge
Basic White Lead Silicate	Sublimed Litharge
Basic Carbonate of White Lead	Red Lead (95%·97%·98%)
Sublimed White Lead	Sublimed Blue Lead

EAGLE EP PICHER

Since 1843

The Eagle-Picher Company
Department RW 1260
Cincinnati 1, Ohio



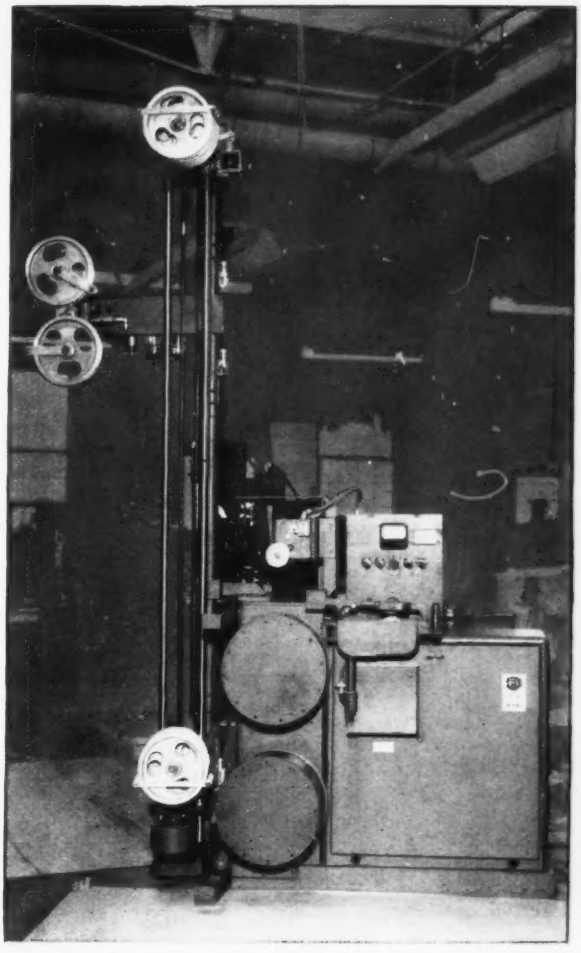
Use CLAREMONT *Cotton* FLOCKS

Claremont has served the rubber industry for over thirty years as a supplier of quality flocks produced to fit specific requirements. Whether used inside or outside, as a filler or as a finish, the superiority of Claremont Cotton Flocks is recognized by all users.

Used as a compounding agent in the manufacture of mechanical rubber goods and general sundries, Claremont Flock Fillers provide reinforcement, improve tear and abrasion resistance. Claremont flock finishes for rubber fabrics provide a wide range of appealing textures that are uniform and long-wearing. In many applications the proper use of a Claremont flock will substantially reduce production costs.

Claremont's knowledge of the industry's needs and its capacity for large production and quick delivery have made it the country's foremost producer of cotton flocks. Samples will be furnished upon request for laboratory and test runs. Inquiries invited!

CLAREMONT FLOCK CORPORATION
CLAREMONT, NEW HAMPSHIRE
The Country's Largest Manufacturer of Flock



WIRE-IN-RUBBER

. . . problem solved

Since early 1930's, National-Standard has been the leader in the design and manufacture of tire bead equipment. Shown above is the latest in the continuing National-Standard product redesign and improvement program—the new Model PFB Pull-off and Festooner. This unit pulls wire from the let-off reels at a rate up to 1000 feet per minute through bead insulating heads, stores and continuously feeds the insulated wire to NS-designed bead machines. The new model features dual-speed control, new safety devices and a direct drive gear reducer, to improve efficiency and output for tire manufacturers.

This is another National-Standard contribution to the improvement of wire-in-rubber processing. Call National-Standard for help in solving your wire-in-rubber problems.

NS NATIONAL-STANDARD COMPANY

NATIONAL-STANDARD COMPANY
Niles, Michigan

news from abroad

Suggest Joint Agency To Market NR

A common marketing agency for all countries producing natural rubber to sell it at a fixed price was suggested as a means of meeting the threat of competition from synthetics. Dr. A. Sundralingam, director of the Ceylon Institute of Scientific & Industrial Research, proposed that Malaya, as the largest natural rubber producer, should take the lead in encouraging other countries to form a joint agency with headquarters in Malaya. The suggested organization would sell to the entire world, including both Communist countries and the West.

So far both the trade and government have indicated that they feel the proposed agency is impracticable and likely to create for the producer greater problems than it can solve. They fear that such a move would slow down trade and that the loss of a free market is clearly undesirable.

Malayan Exports Down

Rubber shipments from Malaya are running lower than in 1959 and so far, even lower than in 1958. Exports totaled 798,230 tons in the first nine months of 1960, against 887,817 tons and 799,915 tons in the corresponding periods of 1959 and 1958, respectively. RSS exports accounted for 443,854 tons in 1960, compared with 509,217 tons in the 1959 period.

Britain was Malaya's best customer for rubber in the period under review, importing 122,862 tons; the United States came second, with 94,542 tons. West Germany and Japan were almost equal, with 74,845 and 73,567 tons, respectively; France bought 51,913 tons; Italy, 40,896; and Russia, 34,300 tons.

Russia, it may be added, has lately come into the market strongly again. In the beginning of November two ships arrived at Singapore to load 18,900 tons of rubber, including 2,500 tons of Indonesian rubber. Two more vessels were expected later in the month to take on another 6,000 tons destined for Russian markets.

Malayan rubber imports in the first nine months of 1960 were 315,446 tons, against 330,109 tons for the same period of 1959.

According to figures published by the Secretariat of the International Rubber Study Group, Malaya produced a total of 5,013 tons of special rubbers in the first half of 1960, including 100 tons of softened and peptized rubber, 20 tons of cyclized rubber, 15 tons of rubber powder, 1,726 tons of Superior Processing rubber, and 3,152 tons of other specialty rubbers. In addition, 6,160 tons of skim rubber were produced.

The totals for concentrated latex prepared in Malaya during the same nine-month period were 59,425 tons, of which by far the greater part, 55,042 tons, was centrifuged latex. Creamed concentrate accounted for 1,393 tons, and other types (including Revertex and electro-decanted latex), for 2,990 tons.

Goodrich, Vanderbilt Plan Argentine Output

B. F. Goodrich Chemical Co., Cleveland, O., and R. T. Vanderbilt Co., New York, N. Y., will jointly manufacture rubber chemicals, including accelerators and antioxidants, in Argentina. The two companies have been associated for many years in the distribution of these chemicals.

Goodrich and Vanderbilt will be associated with Atanor S.A.M., one of Argentina's largest chemical firms, in the Argentine operation. Arrangements will be made for interim production in Atanor facilities while new production facilities are built in the vicinity of Buenos Aires, the announcement said. It added that the planned facilities will be capable of handling current and future requirements of Argentina for rubber chemicals, including those of a new synthetic rubber plant planned for the country.

Six Planters To Merge

Six large rubber companies with plantations in Malaya, Indonesia, and Nigeria are negotiating a merger which will place the proposed amalgamation among the largest rubber plantation companies.

In Malaya this involves 22 rubber estates with a combined planted area of 74,337 acres, 58% in high-yielding *Hevea*. Estimated production of the Malayan estates for the year ending September 30, 1961, is about 36,000 pounds.

There are also 6,779 planted acres in Sumatra, Indonesia, 70% of which are planted in high-grade stock.

The proposed company would be called Kuala Lumpur-Kepong Amalgamated, Ltd. Kuala Lumpur Rubber Co., Ltd., made the original offer for the capital of the five other companies: Kepong (Malaya) Rubber Estates, Ltd., Caledonian (Selangor) Rubber Co., Ltd., Glen Muar Estates, Ltd., Tanjong Malim, Ltd., and Kuala Kangsar Plantations, Ltd.

All the companies involved are said to have up-to-date planting programs, and steadily increasing production is expected if the merger goes through.

Montecatini Granted Second British Patent

The British patent office has granted Montecatini Societa Generale per l'Industra Mineraria e Chimica, Milan, Italy, and Professor Karl Ziegler, of Muehlheim-Ruhr, Germany, a joint patent, their second in the United Kingdom on isotactic polymers.

The patent, No. 828,791, was granted for an industrial process for the selective catalytic polymerization of alpha-olefins having at least three carbon atoms in their molecule, such as propylene, butene-1, and styrene, to isotactic polymers. These are linear, head-to-tail, essentially unbranched polymers containing a desired amount of crystallizable or non-crystallizable macromolecules. The extent of crystallizability depends on the degree of regularity of the obtained macromolecules. Regulation of the process is achieved by a suitable choice of the catalyst components and selection of conditions in which the catalyst is prepared before polymerization.

In particular, the patent covers the commercial process for preparing alpha-olefin polymers consisting substantially of isotactic macromolecules with the aid of catalysts prepared from crystalline hydrocarbon insoluble metal halides and from metal alkyls.

Early last year the United Kingdom granted Montecatini and Ziegler patents covering the production of polypropylene for plastic uses.

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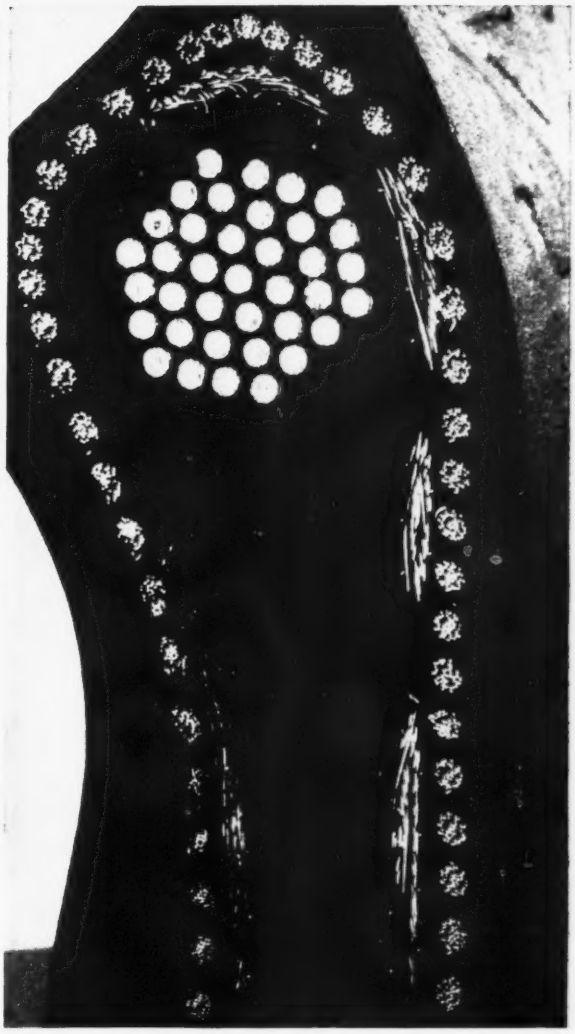

WIRE-IN-RUBBER

. . . problem solved

The hexagonal bead in the photo above is a new type of tire bead developed for use in single wire-ply tires where conventional square beads are not practical. Hexagonal bead grommets are already in metal-ply bus and truck tires now on road tests and under development.

The design and manufacture of a special bead-winding machine for producing a variety of bead-grommet cross sections is another National-Standard contribution to the rubber industry. It is typical of the many solutions to wire-in-rubber problems that have come from National-Standard engineers for over 50 years. Call National-Standard for help in solving your wire-in-rubber problems.

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Polyisoprene Cut to 27¢ as Price of Natural Falls; SBR Latex Price Down

Synthetic Rubber

Shell Chemical Corp. slashed its price on polyisoprene from 32¢, set only a month ago when it went into expanded production, all the way to 27¢ on November 17, as falling natural rubber prices outdated the old price.

Prices of natural rubber had dropped all the way from 44.90¢ a pound, July 1, to 31.15¢ on November 15. After the announcement of the Shell price cut, prices of near rubber plummeted again, to 28.75¢ on November 21.

Prospects seem to indicate even stiffer price competition in the future. Speaking at the annual meeting of The Rubber Manufacturers Association, Inc., in New York, November 18, R. P. Dinsmore, vice president of research and development for the Goodyear Tire & Rubber Co., warned that efforts of natural rubber producers to increase yield will mean a generally lower level of prices that synthetic producers must meet.

In view of the Malayan replanting program and establishment of new plantations in Liberia and Nigeria with prospective high yields, natural rubber may be sold profitably at 25¢ a pound, if not as low as 18-20¢, he said.

Dr. Dinsmore indicated that in order to sell polybutadiene at 25¢ a pound, the price of butadiene monomer would have to be about 10¢ a pound. According to his figures, the present 15¢ price would mean a polymer price of about 30¢. On that basis, with isoprene prices now at 25¢, it is difficult to see polyisoprene prices at 30¢ or under unless a producer can get a special deal on bulk purchases of isoprene.

For that reason there has been considerable interest in recent months in research aimed at cutting the cost of isoprene production. Most prospective producers of stereo rubbers plan to stick to polybutadiene production until the cost of isoprene is brought down to the point where polyisoprene can be produced more cheaply than natural rubber. Shell, which produces its own isoprene supply, is in a better position than most producers to make polyisoprene competitively.

At present Shell is the only company in production with natural synthetics, but both Firestone and Phillips plan to go on stream with polybutadiene in January, and most of the other major producers plan to start production of stereo rubbers either next year or in 1962. If the price of natural rubber continues to drop—and there is no indication that it has hit bottom—most producers will be squeezed to lower their planned prices.

Synthetic producers, however, are counting on demand for rubber over the next decade or two to rise faster than supply. If necessary, they will probably be willing to settle for breaking even while waiting for a price rise. This is because most of the plans for increasing the production of natural rubber through planting high-yield trees are based on completion a decade from now. The Malayan replanting program, for example, is scheduled to be complete in 1970. In the meantime, demand for rubber is rising at a steady rate as Western Europe and other areas increase their use of trucks and automobiles.

The real squeeze over the next few months may come on the SBR producers. Present prices of cold SBR rubbers range from 24 to 26¢ a pound, a differential of only 2-4¢ from natural rubber, compared with 19-21¢ at the beginning of July. A drop in natural prices to 25¢—not at all unlikely under present conditions—could bring a switch by U.S. fabricators to natural. More important, a continued fall in the price of natural would accentuate the preference of Europe for natural rubber. While the United States consumes about 67% synthetic rubber to 33% natural, the ratio in Europe is almost exactly the reverse. Producers of cold SBR polymers might be forced to cut prices in order to keep their share of the market.

Consumption of new rubber in the United States in October was 125,675 long tons, compared with 124,100 long tons in September, according to the monthly report of The Rubber Manufacturers Association, Inc.

Synthetic rubber consumption in October reached 88,455 long tons, against 87,330 long tons in September. The ratio of synthetic rubber consumption to total new consumption edged up slightly to 70.38% from 70.37% in September.

Consumption (in long tons) by type in October was: SBR, 74,160, against 72,593 in September; CR, 6,980, against 7,096 in September; IIR, 4,525, against 4,901 in September; and NBR, 2,790, against 2,740.

Synthetic rubber exports for October totaled 25,085 long tons, contrasted with 24,065 in September. Total stocks in October dropped to 241,122 from 242,959 in September.

Black masterbatch production in October was 4,148 long tons, contrasted with 7,855 long tons in September; oil black masterbatch, 23,323 long tons, against 15,018 long tons in September; and oil masterbatch, 29,654 long tons, against 33,073 long tons in September.

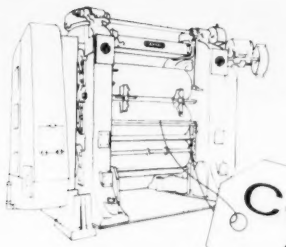
Latex

Dow Chemical Co. cut prices of its SBR latices 2¢ in mid-November, dropping prices of all but a few special SBR latices to 27.5¢ a pound in tank-car quantities. Within the week Koppers Co. and Goodyear Tire & Rubber Co. had cut the price of products in the same category as Dow latices to keep their schedule competitive. Other producers are expected to follow suit.

The Dow SBR latices are mainly low Mooney latices used in paints, building products, packaging, and as coating for paper products. The price change, according to Dow, reflects lower raw material costs and at the same time is intended to increase penetration of the paint, packaging, paper, and building markets.

The statement could be interpreted as meaning that the price cut was made to match a price reduction on ethyl acrylate a week earlier. Rohm & Haas cut prices of ethyl acrylates 1¾¢ a pound, November 5, bringing prices down to 32¼¢ a pound for tank car quantities. Other producers,

MR/202



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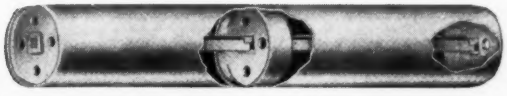

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such as Celanese Corp. of America and Union Carbide Corp., followed suit.

Ethyl acrylate, which is also used for paints, packaging, and coatings, has been priced at 34¢ since late 1955. Between 1952 and 1955, however, prices dropped more than 14¢, from 48.75¢.

The question now is will prices of ethyl acrylates again be cut, touching off a second round of SBR latex cuts.

On the natural rubber side, the market for drum latex is weak. Interest has been spasmodic, with little buying for future delivery. Some producers are reported cutting production because of the poor demand. Producers are predicting greater demand because of dropping latex prices, but they have been predicting such a change for four months without any marked improvement in the market situation. However, stocks had declined from 13,690 tons at the end of August to 12,250 on September 30.

Production of natural latex in Malaya in September was 9,325 tons, compared with 9,558 tons in August. Stocks were 5,932 tons, contrasted with 7,581 tons on August 31.

Prices for ASTM centrifuged concentrated natural latex, in tank-car quantities f.o.b. tank-car, were down to 36.87¢ per pound solids, November 15, compared with 39.28¢ on October 15.

The range of prices of SBR latices was about the same as previously, 26 to 40.24¢ a pound, in spite of the Dow cut. Other prices, unchanged from previous months, were 37 to 57¢ for CR, and 45 to 60¢ for NBR.

(All figures in long tons, dry weight)

Type of Latex	Production	Imports	Consumption	Month-End Stocks
Natural				
Aug.	0	4,174	3,897	13,690
Sept.	0	*	4,250	12,852
SBR				
Aug.	8,096	——	7,877	8,641
Sept.	9,397	——	7,458	9,172
Neoprene				
Aug.	978	0	1,057	1,333
Sept.	1,119	0	942	1,494
Nitrile				
Aug.	1,291	0	1,078	1,967
Sept.	1,299	0	1,122	2,034

* Not available yet for period covered.

Natural Rubber

Prices of natural rubber, which hit 44.90¢ on July 1, dropped all the way to 31.15¢ on November 15, a drop of 13.75¢ in 4½ months. The decline in prices during the October 16-November 15 period was not great, only 2¢. What was much more indicative was the steadiness of the decline.

During the entire period, except for the first drop between July 1 and July 15, prices showed the same phenomenon, a sharp drop of a cent or so, followed by slow recovery making up about half the loss in a week—then another sharp drop in one day. The persistent weakness in the market so indicated was felt by most analysts to be only a symptom of severe problems besetting the natural rubber producers.

The major weakness, of course, was oversupply due to competition from synthetic producers. This translated basically into an overly high production cost for natural rubber. As long as prices were high, the low-yield trees could be kept in production. With U. S. producers switching steadily to higher use of synthetic rubbers, and with synthetic production capacities outside the United States being expanded steadily, the supply of rubber is now outrunning the demand.

The answer is being supplied in Malaya, where the replanting program is expected to produce average yield of 1,200 pounds of rubber per acre by completion of replanting in 1970. Ceylon, where rubber production is concentrated in large estates, already has a high-yield average, and new plantations in Nigeria and Liberia are expected to swell the supply of high-yield rubber. The Firestone plantations in Libera are estimated to yield an average of 1,200 pounds of rubber an acre.

Malaya is finding, however, that expectations of a rising standard of living among its labor force are producing higher wages which nearly offset the rise in productivity. In Africa wages are still low, but the political ferment there is likely to bring about a rising wage standard also.

The answer to date has been further research for better trees and better ways to stimulate yield, aiming at an average yield of 2,000 to 3,000 pounds per acre. To date, however, such results have been achieved only in the laboratory.

Next year and in 1962, when U. S. producers of "synthetic naturals" come on stream, the squeeze on prices will be even greater. By 1965, production of the stereo synthetic rubbers, polyisoprene and polybutadiene, is expected to hit 370,000 long tons a year.

Polyisoprene, which is apparently interchangeable with natural rubber, is not expected to play a large part in the near future because of high costs of the raw material. Polybutadiene, however, is expected to be used in 50-50 blends with natural rubber in areas where only natural rubber has been used to date. One of these is over-the-road truck tires. This use means a decrease in the demand for natural rubber at a time when supply is increasing.

Over the long run, rising demand for all kinds of rubber is expected to stabilize prices of natural rubber. Introduction of polyisoprene and polybutadiene, however, is expected to have one major effect on the natural rubber market. They are expected to eliminate the wild price swings of natural that have occurred so often in the past. Since polyisoprene is interchangeable with natural, and polybutadiene is a superior extender, producers are expected to switch consumption back and forth between natural and synthetics as prices change. The effect will be a fairly stable market at a moderate level.

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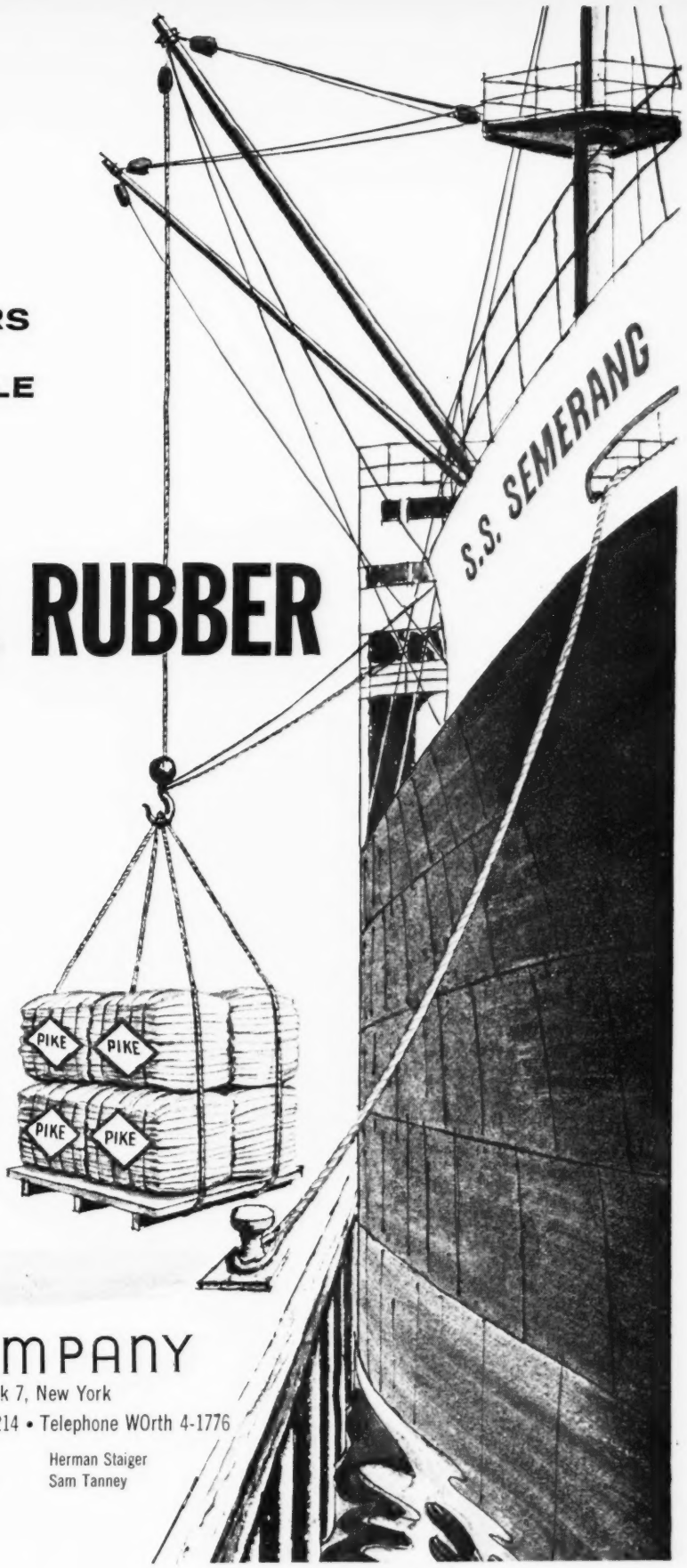

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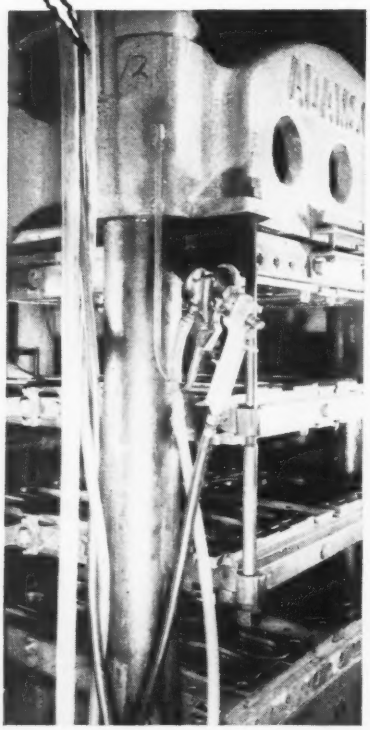

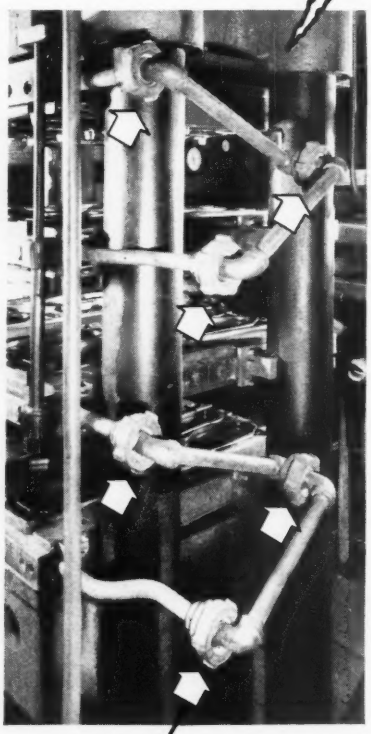

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market reviews

This development is more likely than the suggestion by Ceylonese producers for stabilizing the market by agreement. The latter excludes competition by synthetics.

October sales on the New York Commodity Exchange totaled 11,690 long tons, compared with 10,790 during September. There were 21 trading days in October and the same number in the October 16-November 15 period.

On the physical market, according to the Rubber Trade Association of New York, RSS #1 averaged 34.03¢ in October and 32.53¢ for the October 16-November 15 period, compared with 34.93¢ a pound in September and 35.17¢ for the September 16-October 15 period. Average October sellers' prices were RSS #3, 33.74¢; Amber Blankets, 28.99¢; and Flat Bark, 23.65¢.

REX CONTRACT

	Oct.	Oct.	Nov.	Nov.
1960	21	28	4	11
Nov.	33.85	32.45	31.80	31.50
1961				
Jan.	32.75	31.55	31.25	31.00
Mar.	32.30	31.35	31.10	30.85
May	32.10	31.15	31.02	30.80
July	31.80	30.95	31.00	30.70
Sept.	31.55	30.80	30.75	30.70
Nov.	31.50	30.65	30.65	30.70

NEW YORK OUTSIDE MARKET

	Oct. 21	Oct. 28	Nov. 4	Nov. 11
RSS #1	34.00	32.38	31.75	31.63
#2	33.85	32.25	31.63	31.50
#3	33.75	32.13	31.50	31.38
Pale Crepe				
#1 Thick	35.50	33.85	33.50	33.75
Thin	36.00	34.38	33.75	33.75
#3 Amber Blankets	28.75	27.75	27.25	26.85
#3 Thin Brown Crepe	29.13	27.75	27.25	26.85
Standard Flat Bark	23.50	23.00	22.50	22.25

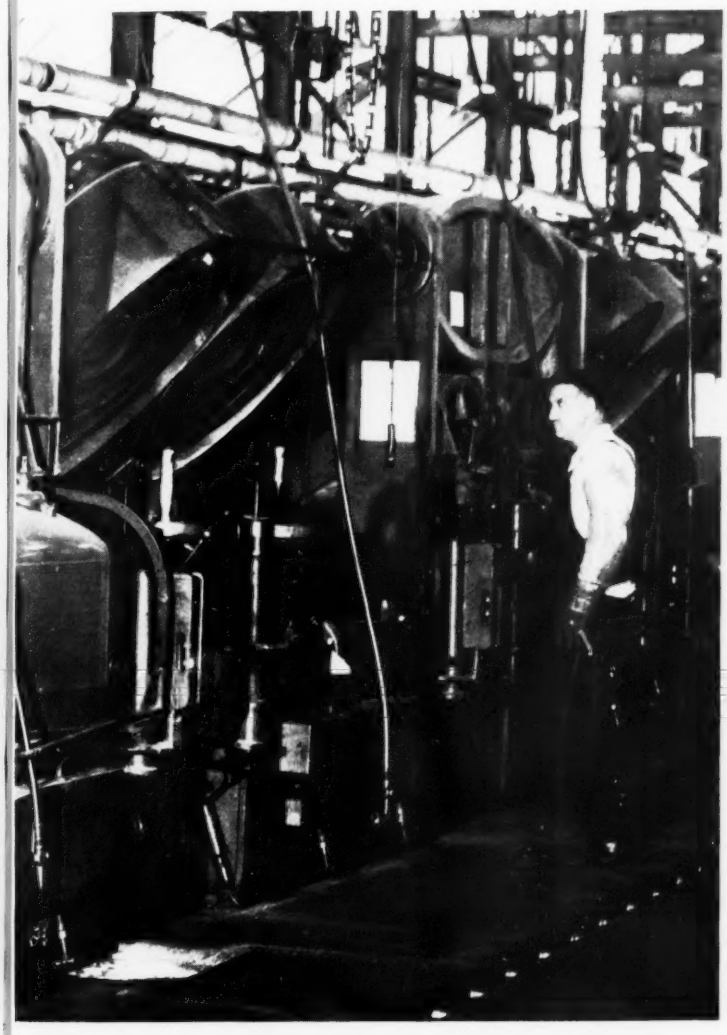
Reclaimed Rubber

Reclaimed rubber business has apparently stabilized at a considerably lower level than in the first half of the year. An eastern relaiming company reports that business over the past four months has been down 16% from the average of the second quarter and down 25% from the average of the first half. This situation is expected to continue for the next six months, according to the company.

Another eastern reclaimer reported that business for the second half of the year may be 10% lower than for the first half and said no change is expected in the near future.

According to the monthly report of The Rubber Manufacturers Association, inc., reclaimed rubber consumption for October increased slightly to 23,075 long tons, compared with 22,101 long tons in September. Production also increased, to 23,605 long tons in October, against 22,251 long tons in Sep-

Keep Production Moving



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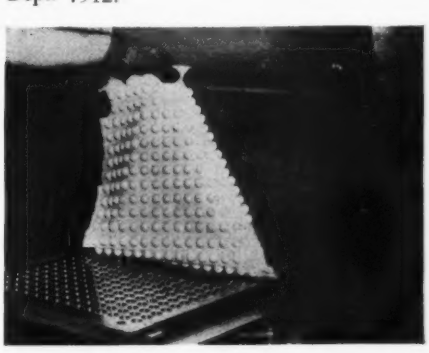
Another money-saving feature: Heat resistant Dow Corning silicone release agents won't carbonize! Build-up on molds is negligible—meaning your mold cleaning costs go down, mold service life goes up.

In short, Dow Corning silicone mold lubricants help you mold superior products—help you maintain economical high speed production.

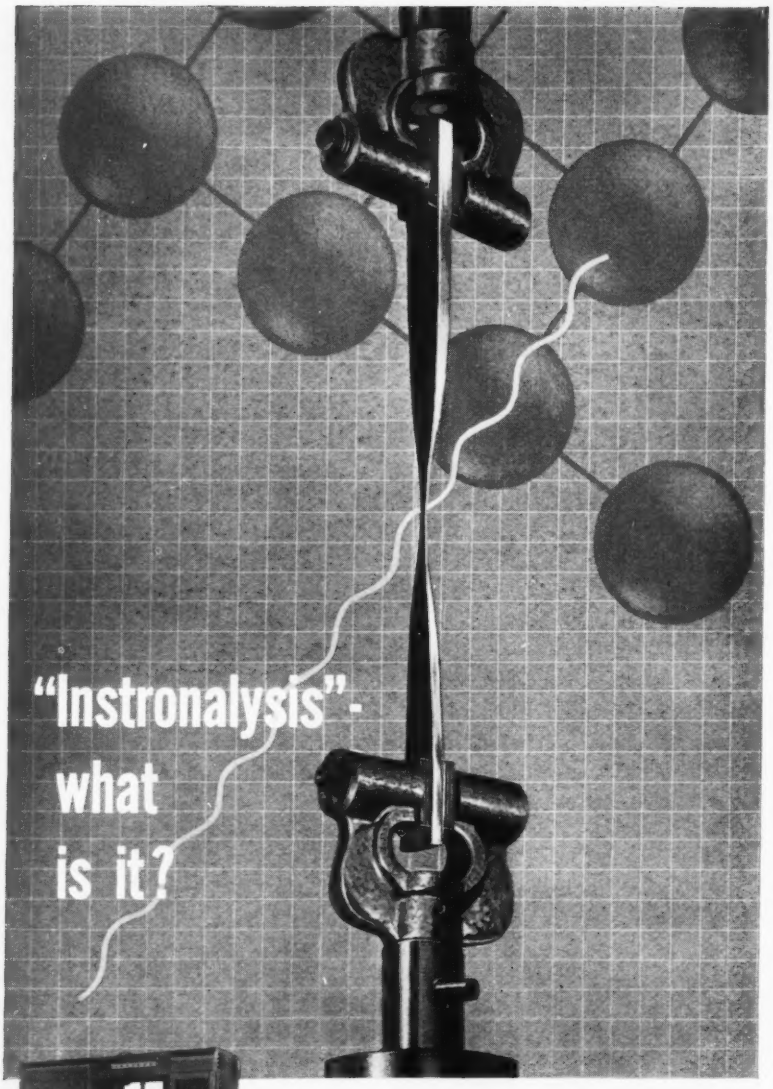


Your best source of technical assistance in adapting silicones to your products or operation is the Dow Corning office nearest you.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.



The Instron comes in various models and sizes, to suit the widest applications — for tests under all sorts of environmental conditions. ILLUSTRATED: **FLOOR MODEL**—load ranges from 2 grams to 10,000 lbs.

Interesting studies on the rheological properties of viscoelastic materials are available in Bulletin PC-2 and R-3. Reprints on many other fields of testing are also available for the asking.

"Instronalysis" means in-depth testing of materials with the Instron Universal Tester. You won't find the word in Webster's, but it is a term of importance to every laboratory concerned with modern testing techniques.

That's because today's technology demands nothing less than in-depth testing. Stress-strain curves alone are no longer adequate to measure the characteristics of long-chain molecular materials and other new "miracle" products. Today's tester must be able to determine the effect of different strain rates at various temperatures, energy loss under repeated cycling, stress relaxation and recovery, recoverable and unrecoverable creep, and many more characteristics beyond the scope of conventional equipment.

"Instronalysis" brings together both routine and advanced testing techniques within easy reach of a single instrument. It's what we mean when we say "You can do more with an Instron."

INSTRON
ENGINEERING CORPORATION
2511 Washington Street, Canton, Mass.

tember. Exports for October reached 1,150 long tons, compared with 1,020 long tons in September. Imports in September were 55 long tons, contrasted with 25 in August. The October figure is not yet available.

RECLAIMED RUBBER PRICES

Whole tire, first line	$0.115
Third line	.107½
Inner tube, black	.17
Red	.22
Butyl	.17
Light carcass	.22
Mechanical, light-colored, medium gravity	.185
Black, medium gravity	.10

The above list includes those items or classes only that determine the price basis of all derivative reclaim grades. Every manufacturer produces a variety of special reclaims, in each general group separately featuring characteristic properties of quality, workability, and specific gravity, at special prices.

Scrap Rubber

The scrap rubber market was very quiet during the October 16-November 15 period, following the drop-off in business in the rubber industry in general and reclaimed rubber in particular. The prices of mixed auto tires remained the same, but the price of mixed auto tubes dropped 0.25¢ a pound, and the price of butyl tubes also dropped 0.25¢.

	Eastern Points	Akron, O.
	Per Net Ton	
Mixed auto tires	$7.00/$12.00	$11.00
S.A.G. truck tires	nom.	nom.
Peeling, No. 1	nom.	33.00
2	nom.	nom.
3	nom.	nom.
	(¢ per Lb.)	
Auto tubes, mixed	4.50	4.50
Black	5.75	5.50
Red	nom.	nom.
Butyl	6.50	6.25

Rayon and Nylon

Production of both nylon and rayon tire cord and fabric dropped off during the third quarter of the year, but significantly nylon's share of the total increased while business was dropping off.

Production of nylon tire cord dropped from 41.2 million pounds in the second quarter to 32.9 million in the third quarter, and production of chafer and other fabrics declined from 2.3 to 1.9 million pounds. Rayon tire cord production dropped from 64.7 million pounds to 51.8 million. Cotton tire cord and fabrics declined from 8.8 million pounds to 6.4 million, and production of chafer and other tire fabrics from 7.9 million pounds to 5.8 million.

Packaged production of high-tenacity rayon yarn during October was 19.4 million pounds, compared with 20 million pounds in September. Shipments

Manufacturers of CANARY LINERS

Mildew-proofing *and* Flame-proofing Cotton Fabrics as per Government Specifications. *Write or Wire for Samples and Quotations.*

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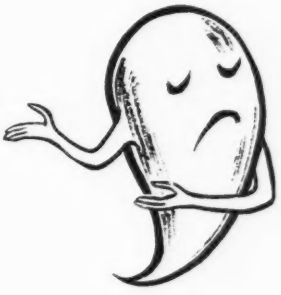

Advantages—

★ Flat Modulus SB-R
★ Balanced Vulcanization with Mixtures SB-R and Natural Rubber
★ Superior Heat Aging
★ Halts Natural Rubber Reversion
★ Safe Processing

SPENCER PRODUCTS CO., INC.
P. O. Box 339 · Ridgewood, New Jersey

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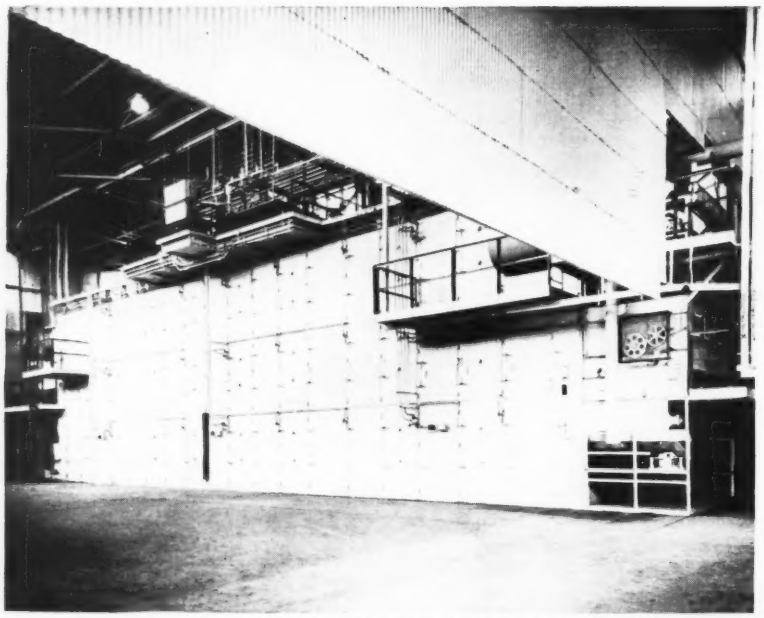

PHOTO COURTESY POLYMER CORPORATION LIMITED, SARNIA, CANADA

Gas-Fired RUBBER DRYING and COOLING . . . by SARGENT

Uniformly dried, uniformly cooled, uniformly clean rubber crumb ready for baling is assured by Sargent Dryers. The entire process is automatic. Production is high. Performance is guaranteed.

Features developed by Sargent over many years of designing and building rubber dryers include: Silicone spraying at the feed end, to help prevent caking or rolling up of the crumb; Dryer sections zoned in groups with separate temperature and humidity controls; Highly efficient airlocks between dryer and cooler compartments; Breakers and brushes to assure a clean conveyor, and to reduce maintenance time and cost; Design that solved the dust problem — collectors are not needed at exhausts; A single housing for dryer and cooler — increases efficiency, speeds the process cycle, lessens possibility of contamination of stock; Housing is covered with full height hinged doors and easily-removed panels for easiest possible cleanout, in least time; Every known safety device for protection of personnel, machine and stock; An exclusive, precision pre-assembly method that makes Sargent equipment the easiest and the quickest — and at lowest cost — of any dryer on the market to install in customer's plant.

Gas burners, safety certified of course, may be mounted on top of the dryer section for more efficient operation, easier servicing. Heat source for Sargent Dryers may also be oil, steam or electricity.

Shown above is a recently installed gas-fired, 3-pass synthetic rubber dryer with cooler. Only 2 gas burners are needed to bring this dryer up to working temperature in less than ten minutes.

Sargent experience and engineering can help you save time, money, man-hours in your drying process, producing a top quality, uniform quality product. Let us give you details.

C. G. SARGENT'S SONS CORPORATION

Graniteville, SINCE 1852 Massachusetts

PHILADELPHIA • CINCINNATI • ATLANTA • CHARLOTTE • HOUSTON • CHICAGO • DETROIT • TORONTO

market reviews

were 18.2 million pounds, against 18.5 the month before, and end-of-the-month stocks dropped to 21 million pounds from 21.1 million pounds.

RAYON PRICES

Tire Fabrics

1100/490/2	$0.69
1650/908/2	$0.58/.615

Tire Yarns

High-Tenacity	
1100/ 490	.49
1100/ 980	.49
1150/ 490, 980	.49
1230/ 490	.49
1650/ 980	.55
1875/ 980	.55
2200/ 980	.55
Super-High Tenacity	
1650/ 720	.55

NYLON PRICES

Tire Yarns

840/140	.92
1680/280	.92

■

News About People

(Continued from page 136)

R. A. Baker, manager of the machinery division of Cabot Corp., Boston, Mass., has been elected a vice president of the corporation. He was vice president and manager of Cabot Shops, Inc., at the time it became part of the corporation.

Thomas F. Regan and **Robert M. Lewis** have been assigned as technical representatives in the metropolitan New York sales region, for Union Carbide Plastics Co. They will have offices at Clifton, N. J.

Carl F. Effler becomes manager, product engineering, of the Akron, O., operation of B. F. Goodrich Aviation Products. He was formerly manager of pressure suit engineering.

■

Western Petrochemical Completes Expansion

Western Petrochemical Corp. has completed a $1.3 million expansion and modernization program at its Chanute, Kan., refinery, which produces high-melting microcrystalline waxes. The facilities are operated by the company's Warwick Wax Division.

The program included installation of new propane deasphalting facilities, additional vacum distillaton units, and a Thermofor Continuous Percolation bleaching unit which provides continuous adsorption bleaching of wax products instead of the batch bleaching of conventional methods.

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SITUATIONS OPEN

SENIOR RESEARCH CHEMISTS

Challenging openings on San Francisco peninsula. Degree in Chemistry or Chemical Engineering. Five to ten years' experience in rubber compounding and production. Record of development in precision molded rubber products. Salary open. Liberal benefits. Advantages of small division with security and financial stability of large corporation. Replies confidential. Send résumé to:

Box No. 2492, c/o RUBBER WORLD

EXPERIENCED CHEMIST OR CHEMICAL ENGINEER to fill a challenging new position in market development for urethane elastomer materials. Mobay is fast-growing associate company of Monsanto with four major plant expansions in past five years. Small company flexibility with big company advantages. Pittsburgh location. Excellent opportunities for advancement. Send résumé in confidence to: Director of Personnel Relations, MOBAY CHEMICAL COMPANY, Penn Lincoln Parkway West, Pittsburgh 5, Pennsylvania.

PRACTICAL RUBBER CHEMIST FOR QUALITY CONTROL AND production supervision of molded rubber products. Medium-size plant located in Phila. area. Address Box No. 2536, care of RUBBER WORLD.

PROGRESSIVE AND EXPANDING NEW ENGLAND RUBBER Manufacturer has an opening with a future for a Chemist or Chemical Engineer with experience in all phases of compounding, development, and production of molded mechanical products. Please submit résumé and salary requirements. Address Box No. 2540, care of RUBBER WORLD.

TECHNICAL MAN FOR TRANSPARENT DIPPED GOODS. MUST know complete set-up. Write Box No. 2541, care of RUBBER WORLD.

CHEMIST PH.D. WITH 2-5 YEARS' EXPERIENCE IN RUBBER field. Senior R & D position in application of synthetic rubber to existing and new uses. Send résumé and salary requirement. **TEXAS-U. S. CHEMICAL CO., DEPT. BWB, LITTLETON ROAD, PARSIPPANY, NEW JERSEY.**

CHEMIST B.S. WITH 2-5 YEARS' EXPERIENCE IN RUBBER or polymer fields. Research in chemistry and properties of synthetic rubber. Send résumé and salary requirements. **TEXAS-U. S. CHEMICAL CO., DEPT. BWB, LITTLETON ROAD, PARSIPPANY, NEW JERSEY.**

MASTER MECHANIC WITH ENOUGH EXPERIENCE TO TAKE charge of maintenance of medium-size company. Old-established Southeastern plant. Address Box No. 2544, care of RUBBER WORLD.

SITUATIONS OPEN (CONT'D.)

PRODUCT SALES MANAGER

Growth Chemical Corporation requires an experienced manager for Florida location, to organize and direct the marketing of new and existing Chemical products to the Rubber Compounding industry.

Requirements: Technical degree plus a minimum of 5 years sales experience in Rubber Chemicals. (Antioxidants, Accelerators, Plasticizers, Fillers, etc.) Should be familiar with and be able to make contributions to general functioning of a sales service laboratory.

Salary and opportunity open, send resume and salary requirements in confidence

Manager Personnel Development

HEYDEN NEWPORT CHEMICAL CORP.

342 Madison Ave. New York 17, N. Y.

SALES REPRESENTATIVE

A challenging opportunity for an experienced man acquainted with sales of fabricated and extruded foam and sponge rubber parts to general industry. National AAA-1 manufacturer. Excellent salary plus incentives. Car optional. Give complete details of business and personal history. Our staff is acquainted with this advertisement.

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SPONGE RUBBER CHEMIST

Wanted for progressive New England factory. Must have good compounding experience and be able to supervise control work and development of new products.

ADDRESS BOX NO. 2543, c/o RUBBER WORLD

statistics of the rubber industry

U. S. Consumption of Natural And Synthetic Rubber*

(Long Tons)

Year	Natural	SBR	IIR	CR	NBR	Total
1959	555,044	886,275	65,454	84,955	34,638	1,626,366
1960						
Jan.	46,354	78,891	6,093	7,361	2,788	141,487
Feb.	46,022	76,999	6,070	7,369	2,765	139,225
Mar.	47,205	81,065	6,324	7,693	2,645	144,932
Apr.	42,032	75,849	5,492	6,525	2,386	132,284
May	41,263	77,423	5,602	6,471	2,497	133,256
June	42,576	80,951	5,150	7,129	2,619	138,425
July	35,229	67,853	4,597	4,936	2,027	114,642
Aug.	37,528	73,761	4,880	7,200	2,737	125,836
Sept.	36,770	72,593	4,901	7,906	2,740	124,100

* Including latex.
Source: Bureau of the Census, Industry Division, Chemicals Branch, United States Department of Commerce.

U. S. Imports and Production of Natural And Synthetic Latices

(Long Tons, Dry Weight)

Year	Natural	SBR	CR	NBR	Total Synthetic	Natural and Synthetic
1959	79,207	93,303	13,127	14,034	120,464	199,671
1960						
Jan.	5,339	9,720	1,154	1,131	12,005	17,344
Feb.	5,812	9,862	1,085	1,098	12,045	17,857
Mar.	5,127	9,351	1,004	1,217	11,572	16,699
Apr.	4,935	9,408	1,137	917	11,462	16,397
May	5,380	8,162	1,250	1,009	10,421	15,801
June	3,335	7,541	965	973	9,479	12,814
July	3,483	6,481	953	983	8,417	11,900
Aug.	4,174	8,096	978	1,291	10,365	14,539
Sept.	...	9,397	1,119	1,299	11,815	...

Source: Bureau of the Census, Industry Division, Chemicals Branch, United States Department of Commerce.

U. S. Imports and Production of Natural and Synthetic Rubber*

(In Long Tons)

Year	Natural	SBR	IIR	CR	NBR	Natural and Synthetic
1959	580,197	1,130,660	81,008	124,815	43,169	1,959,849
1960						
Jan.	34,795	106,853	8,171	11,958	3,760	170,876
Feb.	40,949	104,603	6,514	12,106	3,111	173,095
Mar.	38,580	109,440	7,605	11,305	3,583	170,513
Apr.	36,343	97,963	7,958	11,879	3,095	157,238
May	32,018	102,501	9,814	11,401	3,088	158,822
June	31,639	98,635	9,475	11,614	2,823	154,186
July	28,555	95,584	8,389	10,210	2,401	144,939
Aug.	39,596	98,541	9,804	10,120	3,170	161,231
Sept.	....	90,392	9,183	10,078	3,190	....

* Including latex.
Source: Bureau of the Census, Industry Division, Chemicals Branch, United States Department of Commerce.

U. S. Consumption of Natural and Synthetic Latices

(Long Tons, Dry Weight)

Year	Natural	SBR	CR	NBR	Total Synthetic	Natural and Synthetic
1959	71,745	80,646	11,394	13,258	105,298	177,043
1960						
Jan.	5,493	8,094	999	1,117	10,210	15,703
Feb.	5,463	7,838	969	1,000	9,807	15,270
Mar.	4,847	8,104	1,076	927	10,107	14,954
Apr.	4,199	7,154	913	976	9,043	13,142
May	3,655	6,821	868	978	8,667	11,322
June	3,975	7,147	1,033	981	9,161	13,136
July	2,912	5,433	729	780	6,942	10,854
Aug.	3,897	7,857	1,057	1,078	9,992	13,889
Sept.	4,250	7,458	942	1,122	9,522	13,772

Source: Bureau of the Census, Industry Division, Chemicals Branch, United States Department of Commerce.

U. S. Exports of Synthetic Rubber*

(Long Tons)

Year	SBR	IIR	CR	NBR	Total
1959	220,336	21,700	39,551	8,256	289,843
1960					
Jan.	21,967	2,396	4,185	527	29,075
Feb.	22,791	1,528	4,588	740	29,647
Mar.	27,081	1,803	4,874	532	34,290
Apr.	28,765	2,006	5,268	676	36,715
May	23,337	1,936	4,213	1,320	30,806
June	23,130	2,062	3,699	464	29,355
July	19,721	3,792	4,446	616	28,575
Aug.	22,753	3,494	3,519	501	30,267

* Including latices.
Source: Bureau of the Census, Industry Division, Chemicals Branch, United States Department of Commerce.

U. S. Reclaimed Rubber*

(Long Tons)

Year	New Supply	Consumption	Exports	Stocks
1959	303,345	286,410	12,812	27,738
1960				
Jan.	26,442	26,540	1,106	29,031
Feb.	26,965	25,944	1,258	28,653
Mar.	29,100	26,625	1,542	29,719
Apr.	26,209	24,210	1,248	30,916
May	25,676	23,763	1,167	32,611
June	25,429	24,677	1,164	31,699
July	21,472	19,249	1,384	33,624
Aug.	23,565	21,452	951	33,979
Sept.	22,251	22,101	....	33,949

* Natural and synthetic.
Source: Bureau of the Census, Industry Division, Chemicals Branch, United States Department of Commerce.

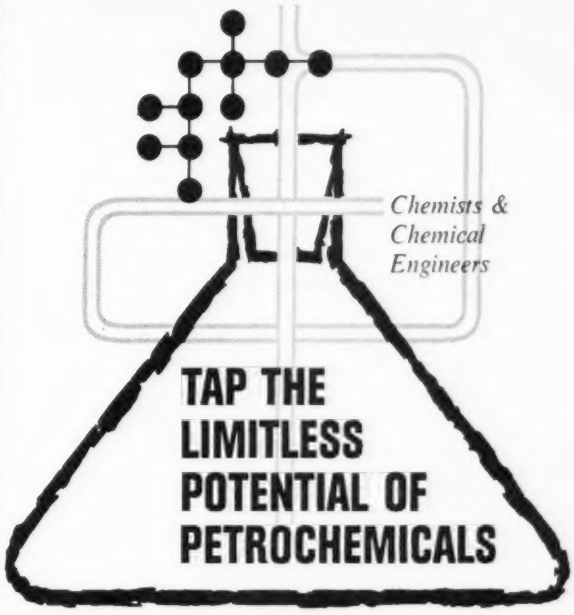
FOAM TECHNOLOGIST
NEEDED BY METAL BUILDINGS LEADER

BUTLER MANUFACTURING COMPANY'S marketing position in metal buildings and plastic panels demands that we enter into the production of foam core panels as soon as possible. We shall also expect other foam-based product ideas.

To realize these opportunities we must supplement our present technical strength with a man who has extensive experience in urethane foams. He will translate strong sales potentials into equipment and plant specifications. His responsibilities will continue to increase according to his desires and demonstrated ability.

We prefer someone with at least a Bachelor's Degree in Chemistry or Chemical Engineering, and with industrial laboratory work with foams. We prefer also that he have experience with rigid and flexible foam production systems. Proved ability to innovate will be invaluable.

Your answer, which will be kept in complete confidence, should include a personal resume and be sent to Mr. Orval W. Groves, Employment Supervisor, Butler Manufacturing Company, 7400 East 13th Street, Kansas City 26, Missouri.



Expanding R&D Activities Create New Staff Positions at ESSO RESEARCH & ENGINEERING

Recognizing that petroleum offers a virtually unlimited—and still relatively untapped—source of new petrochemical products, ESSO sponsors one of the largest research and development operations in the oil industry.

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Forward replies in complete confidence to
Mr. C. D. Gardei, Professional Employment—Dept. W

ESSO RESEARCH & ENGINEERING CO.
P.O. Box 175 • Linden, N.J.

World Production of Natural Rubber

(1,000 Long Tons)

Year	Malaya		Indonesia		All Other	Total
	Estate	Native	Estate	Native		
1959	408.4	289.8	215.6	505.8	645.4	2,065.0
1960						
Jan.	37.4	27.5	18.0	28.0	59.4	170.0
Feb.	32.1	22.6	17.4	32.9	45.7	152.5
Mar.	30.0	25.0	15.8	34.8	57.0	162.5
Apr.	28.1	18.8	14.7	40.4	53.0	155.0
May	33.0	23.8	16.7	32.3	54.2	160.0
June	34.3	24.0	16.7	31.8	54.6	160.0
July	37.1	26.0	17.9	27.9	46.1	155.0

Source: Secretariat of the International Rubber Study Group.

World Consumption of Natural Rubber*

(1,000 Long Tons)

Year	U. S.	Eastern Europe and China†	U. K.	France	Germany	World Total†
1959	555.0	346.8	180.6	133.5	144.1	2,112.5
1960						
Jan.	46.4	45.4	14.7	11.2	11.8	182.5
Feb.	46.0	31.9	14.3	11.4	12.3	172.5
Mar.	47.2	15.0	17.3	12.1	13.1	162.5
Apr.	42.0	26.9	13.5	11.0	11.0	160.0
May	41.3	24.9	14.3	11.2	11.9	160.0
June	42.6	35.9	16.4	11.2	10.8	175.0
July	35.2	...	11.2	10.3	10.8	155.0
Aug.	37.3	...	10.2	...	...	....

* Figures include latices.
† Estimated or partly estimated.
Source: Secretariat of the International Rubber Study Group.

World Production of Synthetic Rubber*

(1,000 Long Tons)

Year	U. S.	Canada	Germany	U. K.	Italy	Japan	Total
1959	1,379.7	100.7	48.1	57.0	47.0	1.2	1,640.0
1960							
Jan.	130.7	12.6	5.9	6.0	5.0	..	165.0
Feb.	126.3	12.9	5.8	5.8	5.0	..	160.0
Mar.	131.9	14.2	7.3	7.7	5.5	..	165.0
Apr.	120.9	13.2	7.0	6.9	5.5	1.1	157.5
May	126.8	13.5	5.6	6.2	5.5	1.8	162.5
June	122.5	13.5	5.4	8.1	5.5	3.3	160.0
July	116.6	12.8	7.8	7.4	6.0	..	155.0
Aug.	121.6	12.7	..	7.6	..	..	....

* Figures include latices. No data available from Iron Curtain countries.
Source: Secretariat of the International Rubber Study Group.

World Consumption of Synthetic Rubber*

(1,000 Long Tons)

Year	U. S.	Canada	U. K.	France	Germany	Japan	Total†
1959	1,072.7	57.2	79.0	66.2	73.4	32.1	1,575.0
1960							
Jan.	95.1	4.8	8.4	6.9	7.3	3.9	142.5
Feb.	93.2	5.2	8.5	7.5	8.3	4.2	145.0
Mar.	97.7	5.4	10.5	8.1	9.0	4.6	155.0
Apr.	90.3	4.4	8.4	7.6	7.7	4.8	145.0
May	92.0	4.2	9.0	8.0	8.9	4.9	147.5
June	95.8	5.0	10.0	8.0	8.2	4.9	152.5
July	79.4	3.9	7.8	7.4	8.4	..	132.5
Aug.	88.6	3.8	7.0	..	..	..	....

* Including latices.
† Figures estimated. No account has been taken of synthetic rubber originating in Eastern Europe.
Source: Secretariat of the International Rubber Study Group.

U. S. Rubber Industry Sales and Inventories

(Millions of Dollars)

	Values of Sales*				Manufacturers' Inventories*			
	1957	1958	1959	1960	1957	1958	1959	1960
Jan.	496	448	508	530	1,047	1,100	1,013	1,148
Feb.	495	413	490	540	1,036	1,087	1,032	1,140
Mar.	476	412	506	510	1,030	1,112	1,030	1,160
Apr.	490	429	543	530	1,031	1,047	1,015	1,190
May	481	428	524	550	1,024	1,020	995	1,180
June	458	445	520	520	1,027	986	1,013	1,200
July	514	478	519	480	1,045	980	1,075	1,230
Aug.	481	438	492	480	1,074	1,024	1,113	1,240
Sept.	481	464	544	510	1,074	1,024	1,114	1,210
Oct.	490	493	555	...	1,097	1,022	1,115	...
Nov.	431	472	482	...	1,101	1,018	1,120	...
Dec.	427	518	508	...	1,092	994	1,124	...
Total	5,720	5,438	6,191	...	12,678	12,414	12,759	...

* Adjusted for seasonal variation.
Source: Office of Business Economics, United States Department of Commerce.

U. S. Tire Fabric Production

(Millions of Pounds)

	Tire Cord & Fabrics			Chafer & Other Fabrics		
	Nylon	Rayon	Cotton	Nylon	Cotton	Total
1960						
Apr.-June*	41.2	64.7	.8	2.3	7.9	116.9
July-Sept.	32.9	51.8	.7	1.9	5.8	93.1

* Breakdown between nylon and cotton tire fabric production not available for earlier periods.
Source: Bureau of the Census, United States Department of Commerce.

U. S. Rubber Industry Economic Indicators

Year	Production Index* Total Rubber and Plastics Products Seasonally Adjusted, %		Without Seasonal Adjustment, %		% Return† On Sales	% Return† On Investment
	1947-49	1957	1947-49	1957	R&MP‡	R&MP
	100	100	100	100		
1959	199	114	199	114	4.0	8.6
Jan.	189	108	198	113		
Feb.	197	113	208	119		
Mar.	196	112	206	118	3.9	8.0
Apr.	182	104	187	107		
May	183	105	179	103		
June	205	117	199	114	4.4	10.4
July	223	128	187	107		
Aug.	210	120	203	117		
Sept.	209	120	212	121	4.1	8.8
Oct.	201	115	211	121		
Nov.	198	113	203	116		
Dec.	203	116	194	111	3.7	8.0
1960						
Jan.	206	118	216	124		
Feb.	201	117	215	123		
Mar.	201	115	211	121	3.8	8.0
Apr.	201	115	201	118		
May	205	117	201	115		
June	214	122	208	119	3.9	8.4

* F.R.B. Index of Industrial Production revised to include plastics products and change base period.
† Base Data F.I.C.-S.E.C.-Quarterly Financial Reports—% Calculated by RMA.
‡ R&MP = Rubber and Miscellaneous Plastics, a classification revised according to the 1959 Standard Industrial Classifications.

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1—Peerless guillotine cutter, 30" blade, with motor.
1—Allen 4" extruder with 25-HP. motor.
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FOR SALE—LABORATORY MILLS—6 x 12", 6 x 13", 6 x 16", 8 x 18", self-contained with reduction drive, brake, and motor. Prompt Delivery. RUBBER & PLASTIC MACHINERY OF NEW JERSEY, P. O. Box 1543, Trenton, New Jersey.

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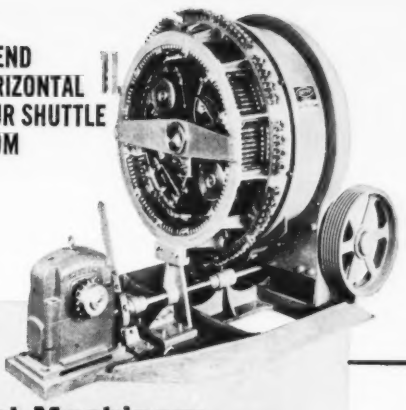

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UNITED RUBBER MACHINERY EXCHANGE
183-189 ORATON ST. CABLE "URME" NEWARK 4, N. J.

Carbon Black Statistics—January-September, 1960

Furnace blacks are classified as follows: SRF, semi-reinforcing furnace black; HMF, high modulus furnace black; GPF, general-purpose furnace black; FEF, fast-extruding furnace black; HAF, high abrasion furnace black; SAF, super abrasion furnace black; ISAF, intermediate super abrasion furnace black.

(Thousands of Pounds)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Production									
Furnace types									
Thermal	14,746	12,438	14,690	13,481	13,337	12,004	11,481	11,237	10,574
SRF	27,138	25,673	28,063	30,176	30,380	27,179	28,879	26,802	23,856
HMF	6,645	5,919	5,777	6,883	7,361	6,889	5,492	6,103	7,246
GPF	9,462	9,722	9,833	10,420	10,711	10,792	11,315	11,284	8,883
FEF	21,450	22,599	23,423	20,449	22,938	20,825	20,449	20,444	16,588
HAF	49,793	43,816	44,466	43,049	52,592	44,695	44,694	41,082	37,800
SAF	....	1,549	1,778	2,837	357	2,051	905	1,617	547
ISAF	24,744	25,283	30,116	29,720	26,299	25,610	25,413	28,898	27,738
Total furnace	153,978	146,999	158,146	157,015	163,975	150,045	148,628	147,467	133,232
Contact types	25,590	23,503	25,099	25,155	25,105	23,643	23,928	23,994	24,058
Totals	179,568	170,502	183,245	182,170	189,080	173,688	172,556	171,461	157,290
Shipments									
Furnace types									
Thermal	19,372	9,159	14,100	12,130	12,531	11,475	9,805	12,299	12,349
SRF	25,327	25,680	29,378	28,175	25,877	23,960	24,441	25,430	25,752
HMF	5,533	6,780	6,759	6,977	5,727	5,265	4,867	5,548	4,547
GPF	8,194	9,034	9,556	11,547	11,056	10,320	9,502	9,968	10,531
FEF	20,845	20,824	22,421	19,258	17,416	20,403	17,128	17,933	19,434
HAF	45,492	42,592	44,037	45,443	39,810	43,740	35,338	46,838	37,787
SAF	826	993	1,483	1,559	1,861	1,505	1,801	894	729
ISAF	23,034	27,284	28,253	26,101	26,026	27,838	26,643	23,529	25,105
Total furnace	148,623	142,346	155,987	151,190	140,304	144,506	129,525	142,439	135,234
Contact types	40,807	15,474	23,666	26,247	22,493	20,806	20,258	24,663	24,073
Totals	189,430	157,820	179,653	177,837	162,797	165,312	149,783	167,102	159,307
Producers' Stocks, End of Period									
Furnace types									
Thermal	16,097	19,376	19,966	21,317	22,123	22,652	24,328	23,266	21,491
SRF	24,506	24,543	23,228	25,229	29,732	32,951	37,389	38,761	37,865
HMF	4,894	4,033	3,051	2,957	4,591	6,215	6,840	7,395	10,094
GPF	6,253	6,941	7,218	6,091	5,746	6,218	8,031	9,347	7,699
FEF	10,957	12,732	13,734	14,925	20,447	20,869	24,190	26,701	23,855
HAF	35,630	36,854	37,283	35,092	47,874	48,829	58,185	52,429	52,442
SAF	3,254	3,810	4,105	5,383	3,879	4,425	3,529	4,252	4,070
ISAF	30,364	28,363	30,226	33,845	34,118	31,890	30,660	36,029	38,662
Total furnace	131,955	136,652	138,811	144,839	168,510	174,049	193,152	198,180	196,178
Contact types	52,025	60,054	61,487	59,995	62,607	65,444	69,114	68,445	68,430
Totals	183,980	196,706	200,298	204,834	231,117	239,493	262,266	266,625	264,608
Exports									
Furnace types									
Total furnace	37,598	26,574	35,408	41,367	30,769	30,319	29,120	32,661	....
Contact types	23,310	10,635	8,920	13,862	8,774	10,526	8,630	13,591	....
Totals	60,908	37,209	44,328	55,229	39,543	40,845	37,750	46,252	....

Source: Bureau of Mines, United States Department of the Interior, Washington, D. C.

U. S. Rubber Use by Products

(1,000 Long Tons)

Year	Transportation			Non-Transportation			Grand Total
	Natural	Synthetic	Total	Natural	Synthetic	Total	
1956	364.0	533.0	897.0	198.1	341.3	539.5	1,436.5
1957	342.7	583.5	926.2	196.0	342.4	538.5	1,464.6
1958	302.0	558.9	860.9	182.4	321.0	503.5	1,364.4
1959	354.7	669.6	1,024.3	200.4	401.7	602.1	1,627.7
1959							
3rd qt.	94.0	182.7	276.7	49.7	98.8	148.6	425.8
4th qt.	86.7	167.2	253.8	47.4	104.4	151.7	406.0
1960							
1st qt.	94.8	176.1	270.9	44.8	110.0	154.7	425.7
2nd qt.	87.2	176.7	263.9	38.7	101.4	140.0	404.0
3rd qt.	73.7	160.4	234.0	35.6	95.0	130.5	364.5

Source: United States Department of Commerce, Business & Defense Services Administration.

U. S. Automotive Inner Tubes

(Thousands of Units)

Year	Shipments				Production	Inventory End of Period
	Original Equipment	Replacement	Export	Total		
1959	3,624	41,522	890	46,036	46,059	10,536
1960						
Jan.	365	4,964	62	5,391	3,899	8,924
Feb.	370	3,553	87	4,011	4,043	9,002
Mar.	365	2,807	111	3,282	4,241	10,113
Apr.	330	2,862	114	3,306	3,628	10,495
May	307	2,932	91	3,330	3,611	10,852
June	295	3,154	98	3,547	3,426	10,670
July	242	3,102	94	3,439	3,261	10,627
Aug.	169	3,056	83	3,308	3,017	10,254
Sept.	232	2,563	100	2,894	3,024	10,446

Source: The Rubber Manufacturers Association, Inc.

MACHINERY AND SUPPLIES FOR SALE (CONT'D.)

SUBSTANTIAL SAVINGS ON GOOD EQUIPMENT

Unused F-B 14" x 30" Two-Roll Mills. Good used 2-Roll Mills, 12" x 24", 22" x 60". 3-Roll Calender 22" x 58" with accessories. 6 Southwark Presses, 36" x 36", 14" Ram. Stewart-Bolling Press 36" x 36", 22" Ram. HPM Self-Cont. Presses, 7- and 25-Ton. F-B Unused Belt Press 52" x 31'. EXTRUDERS: NRM 1½"; NRM 6" Rubber Tuber. Royle 2" Extruder; Hydraulic Strainer 15". VULCANIZERS: 6' x 16', 41" x 54", 2' x 4', others. Utility Rubber Stock Cutter with Conveyor. Baker Perkins 150-Gal. Dispersion Mixer, 150 HP. J. H. Day Mogul Mixer, 150-Gal., Vac. Cov., 75 HP. Baker Perkins 5-gal. Dispersion Mixer, 30 HP. Banbury #9: J. H. Day 40-gal. Pony Mixers. Inquire about the FMC Rental-Purchase Plan. FIRST MACHINERY CORP., 209-289 Tenth Street, Brooklyn 15, New York. Phone ST 8-4672. Cable "Effemcy."

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600-Ton Adamson Slab Side 8-Opening Hydraulic Press, 42" x 42" platen, steamheated. 26" Chrome Plated Ram. 6" x 13" and 7" x 16" Laboratory Mills. 42", 50", 60", and 84" mill sizes in stock. 1000-Ton Hydraulic Presses manufactured by Baldwin Southwark and Clearing. 42" down-acting ram x 66" stroke. 140" daylight opening, 60" x 54" bed area. Eemco 3-opening 24" x 30" hydraulic presses. 16" diameter ram. 16" x 30" Farrel Cracker Mill with corrugated roll. Driven by 100-HP. motor and reduction drive. Royle # 2 3¼" Rubber Extruder. Span Grinder, complete 25-HP. motor. We carry a complete line of equipment for the rubber and plastic industries. WE WILL FINANCE. What do you need? What do you have for sale? JOHNSON MACHINERY COMPANY, 90 Elizabeth Avenue, Elizabeth, New Jersey. ELizabeth 5-2300. WE SPECIALIZE IN PLANT LIQUIDATIONS, AND PURCHASES.

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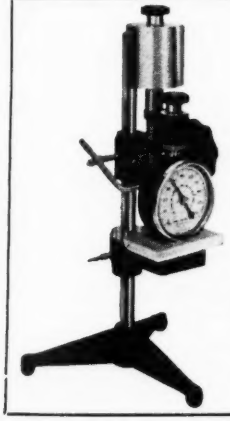
FOR SALE: 1—10" x 24" THROPP 3-ROLL CALENDER; 1—8" Allen strainer, 75 HP; 1—3½" National Erie extruder; 1—32" x 32" hydraulic press, 16" ram. CHEMICAL AND PROCESS MACHINERY CORP., 52 9th Street, Brooklyn 15, N. Y., HY 9-7200.



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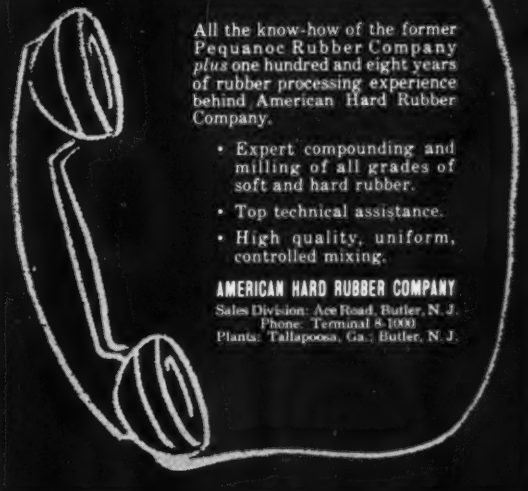

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U. S. Rubber Industry Employment, Wages, Hours

Year	Production Workers (1000's)	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Consumer's Price Index
All Rubber Products					
1939	121.0	$27.84	39.9	$0.75	
1959					
Jan.	199.1	100.28	41.1	2.44	123.8
Feb	198.8	101.09	41.6	2.43	123.7
Mar.	201.5	103.74	42.0	2.47	123.7
Apr.	176.0	101.57	41.8	2.43	123.9
May	171.8	101.46	42.1	2.41	124.0
June	196.1	98.74	40.3	2.45	124.5
July	203.4	107.10	42.5	2.52	124.9
Aug.	203.8	105.33	42.3	2.49	124.8
Sept.	212.4	102.01	41.3	2.47	125.2
Oct.	212.3	101.18	40.8	2.48	125.5
Nov.	209.1	97.66	39.7	2.46	125.6
Dec.	208.0	101.59	40.8	2.49	125.5
1960					
Jan.	208.0	102.16	40.7	2.51	125.4
Feb.	208.6	100.00	40.0	2.50	126.5
Mar.	207.5	97.10	39.4	2.48	125.7
Apr.	200.7	94.60	38.3	2.47	126.2
May	197.6	100.04	39.4	2.52	126.3
June	197.9	102.72	40.6	2.56	126.5
July	192.2	103.94	40.6	2.56	126.6
Aug.	192.9				126.6
Rubber Footwear					
1939	14.8	$22.80	37.5	$0.61	
1959					
Jan.	17.1	78.20	39.9	1.96	
Feb.	17.1	80.59	40.7	1.98	
Mar.	17.4	79.79	40.3	1.98	
Apr.	17.2	73.05	39.7	1.84	
May	17.7	79.58	40.6	1.96	
June	18.2	81.58	41.2	1.98	
July	18.3	78.60	40.1	1.96	
Aug.	18.4	79.17	40.6	1.95	
Sept.	19.0	79.18	40.4	1.96	
Oct.	19.1	79.40	39.9	1.99	
Nov.	19.6	79.80	39.9	2.00	
Dec.	19.4	80.79	39.8	2.03	
1960					
Jan.	19.0	79.40	39.5	2.01	
Feb.	19.0	77.21	38.8	1.99	
Mar.	18.9	78.61	39.5	1.99	
Apr.	18.5	77.01	38.7	1.99	
May	18.1	81.40	40.1	2.03	
June	18.2	82.82	40.6	2.04	
July	17.6	82.21	40.3	2.04	
Tires and Tubes					
1939	54.2	$33.36	35.0	$0.96	
1959					
Jan.	76.9	117.55	41.1	2.86	
Feb.	76.2	118.98	41.6	2.86	
Mar.	77.9	122.96	42.4	2.90	
Apr.	93.1	123.98	42.9	2.89	
May	66.0	126.13	42.9	2.94	
June	52.2	108.93	36.8	2.96	
July	79.7	128.74	43.2	2.98	
Aug.	78.4	127.74	43.3	2.95	
Sept.	80.5	117.56	40.4	2.91	
Oct.	79.7	117.49	40.1	2.93	
Nov.	79.0	112.62	38.7	2.91	
Dec.	78.1	118.59	40.2	2.95	
1960					
Jan.	77.9	119.80	40.5	2.98	
Feb.	77.4	117.71	39.5	2.98	
Mar.	78.8	113.68	38.8	2.93	
Apr.	78.1	107.38	36.9	2.91	
May	77.0	117.51	39.7	2.96	
June	76.6	121.39	40.6	2.99	
July	76.3	123.82	41.0	3.02	

Source: BLS, United States Department of Labor.

Year	Production Workers (1000's)	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Consumer's Price Index
Other Rubber Products					
1939	51.9	$23.34	38.9	$0.61	
1959					
Jan.	105.1	91.27	41.3	2.21	
Feb.	105.5	91.96	41.8	2.20	
Mar.	106.2	93.02	41.9	2.22	
Apr.	97.1	90.03	41.3	2.18	
May	101.9	92.18	41.9	2.20	
June	107.2	94.98	42.4	2.24	
July	105.4	95.40	42.4	2.25	
Aug.	107.0	93.21	41.8	2.23	
Sept.	112.9	94.73	42.1	2.25	
Oct.	113.5	93.38	41.5	2.25	
Nov.	110.5	89.87	40.3	2.23	
Dec.	110.5	92.93	41.3	2.25	
1960					
Jan.	111.1	93.52	41.2	2.27	
Feb.	112.2	91.76	40.6	2.26	
Mar.	109.8	89.78	39.9	2.25	
Apr.	104.1	88.43	39.3	2.25	
May	102.5	90.12	39.7	2.27	
June	103.1	92.34	40.5	2.28	
July	98.3	91.88	40.3	2.28	

U. S. Automotive Pneumatic Casings

(Thousands of Units)

Year	Shipments: Original Equipment	Shipments: Replacement	Shipments: Export	Shipments: Total	Production	Inventory End of Period
Passenger Car						
1959	29,768	66,834	788.3	97,388	102,681	23,599
1960						
Jan.	3,912	6,006	111	10,030	9,011	22,567
Feb.	3,569	5,257	78	8,804	9,371	22,972
Mar.	3,333	5,156	90	8,578	9,679	24,144
Apr.	3,200	6,558	114	9,872	9,165	23,512
May	3,361	6,542	78	9,981	9,548	22,985
June	3,098	7,099	94	10,290	9,544	22,271
July	2,456	6,377	82	8,915	8,680	22,097
Aug.	1,359	6,389	76	7,824	8,061	22,326
Sept.	2,676	5,749	59	8,484	8,158	22,037
Truck and Bus						
1959	4,407	10,015	644	15,075	15,238	
1960						
Jan.	421	826	45	1,292	1,315	3,376
Feb.	428	789	59	1,275	1,401	3,502
Mar.	421	671	67	1,158	1,436	3,777
Apr.	385	790	68	1,207	1,321	3,982
May	363	764	80	1,207	1,321	3,982
June	352	785	80	1,216	1,319	4,087
July	279	851	68	1,197	1,109	4,011
Aug.	219	823	75	1,117	1,085	3,972
Sept.	273	811	61	1,146	1,026	3,856
Total Automotive						
1959	34,183	76,848	1,433	112,465	117,918	26,955
1960						
Jan.	4,333	6,833	156	11,322	10,325	25,943
Feb.	3,996	6,047	136	10,179	10,772	26,473
Mar.	3,753	5,827	157	9,737	11,115	27,921
Apr.	3,584	7,347	182	11,114	10,517	27,401
May	3,724	7,306	157	11,188	10,779	26,967
June	3,449	7,884	174	11,507	10,863	26,359
July	2,735	7,228	150	10,113	9,789	26,108
Aug.	1,578	7,213	151	8,941	9,147	26,298
Sept.	2,950	6,560	120	9,630	9,184	25,893

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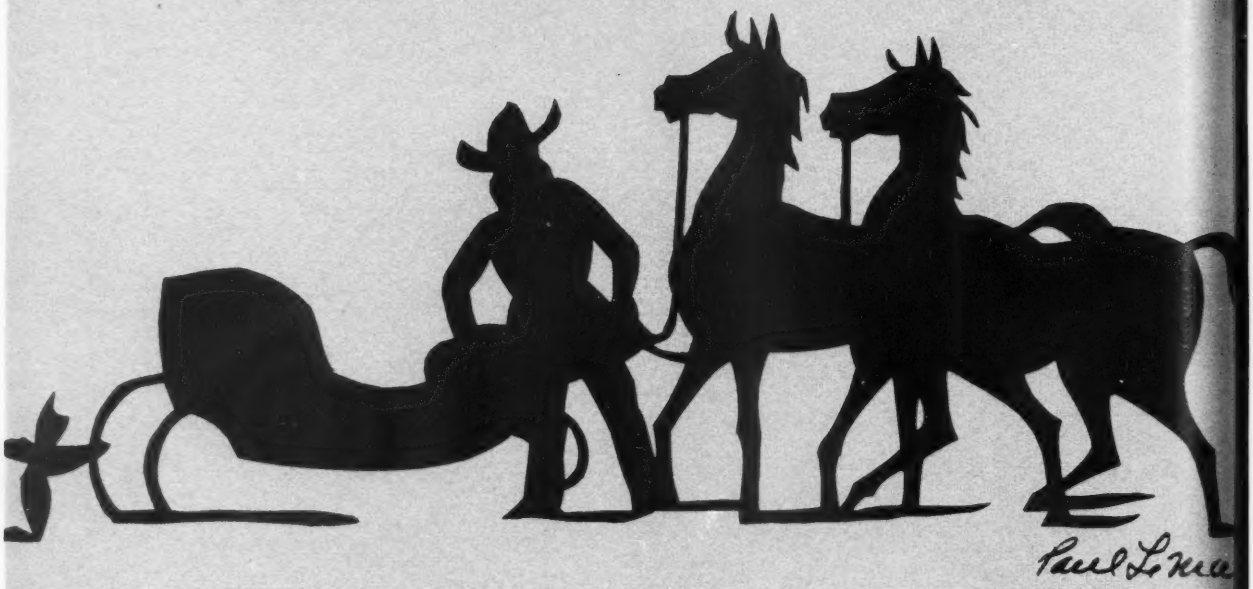

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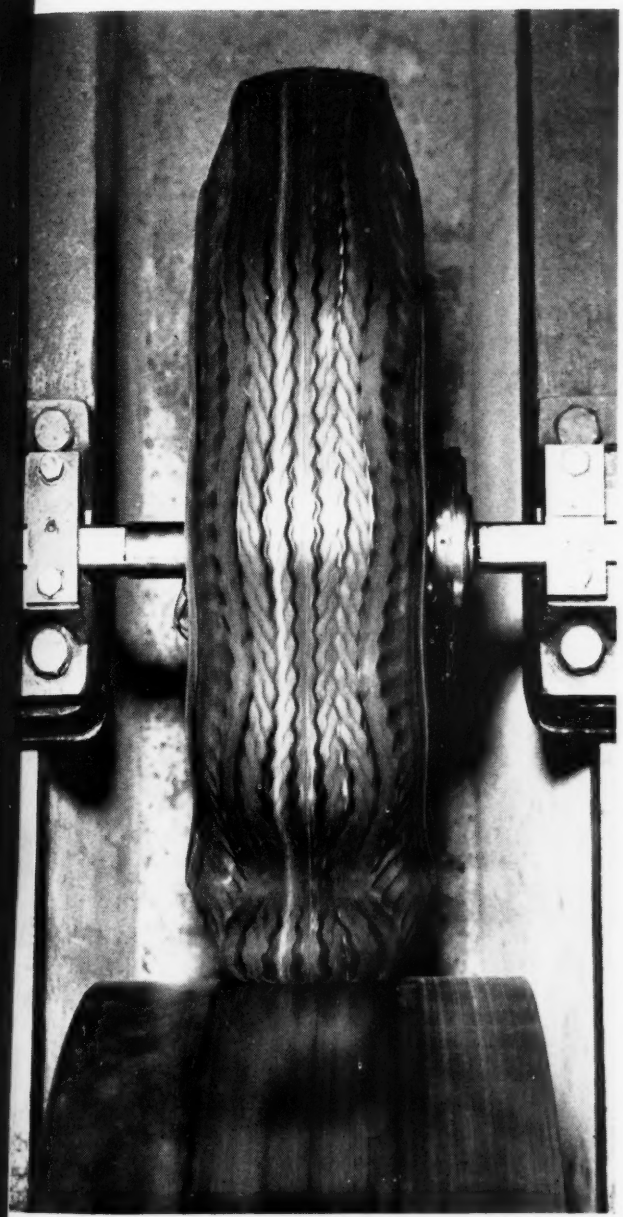

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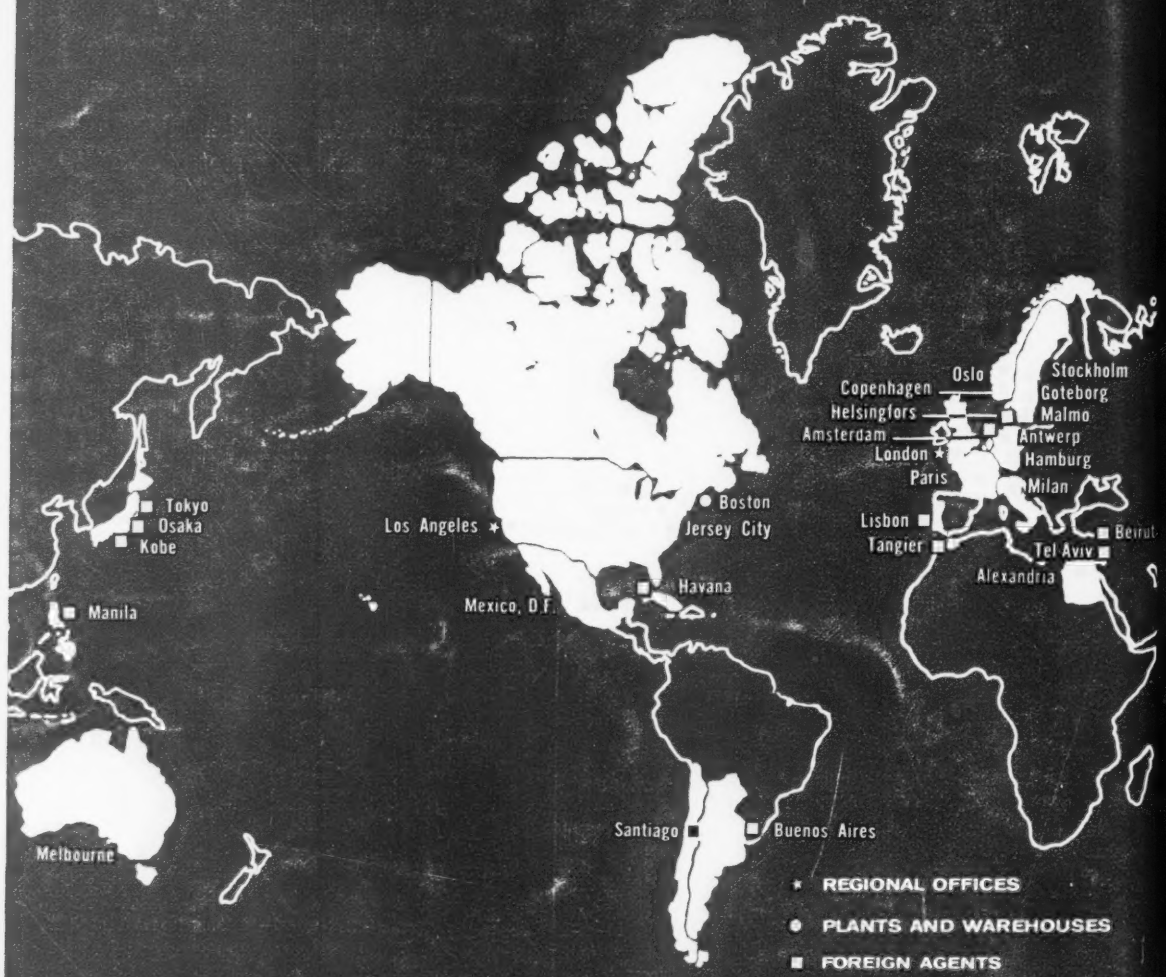

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